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NOSE, THROAT AND EAR

KNIGHT AND BRYANT

DISEASES
OF THE
NOSE, THROAT AND EAR

BY

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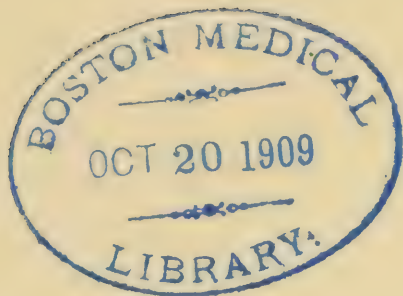
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SECOND EDITION, REVISED
WITH 239 ILLUSTRATIONS

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PREFACE TO SECOND EDITION.

In preparing a new edition of "Diseases of the Nose and Throat" numerous minor changes have been made throughout. The chief additions will be found in the chapters on Deviated Septum and Diseases of the Accessory Sinuses. The extraordinary activity of recent years in the regions concerned has led to the adoption of rather extreme opinions in some particulars, which time and further experience will probably modify. There is no doubt, however, that distinct progress has been made toward placing the treatment of deformities of the nasal septum and chronic inflammation of the sinuses on a more precise and scientific basis. It only remains to determine the limitations of new operations and to select suitable cases for their application.

To those who anticipate a revolution in laryngoscopy from the introduction of the direct method of examination (Kirstein), which perhaps constitutes one of the most important advances in our speciality, it may seem that scant attention has been given to manipulations in the upper air tract in this way. Two reasons for this course have prevailed. In the first place, it is not likely that the older methods of exploration will be supplanted as a matter of routine. The class of cases within its scope (foreign bodies, new growths in children, neoplasms at the anterior commissure or below the vocal bands, etc.) offers a comparatively restricted field for the new procedure. In the second place, the special apparatus required and the unusual operative skill demanded are more or less prohibitive as to general use. It therefore seems more judicious to leave detailed description to special monographs and relinquish the procedure itself to the few who have given the subject particular attention.

In this country the industry and ingenuity of Jackson, Ingals and Mosher and abroad of Killian and Bruenings have combined to bring the operation to a stage of almost absolute perfection. Its great advantage in surgical work must be admitted, but the results

attained by the ordinary modes of examination are in general satisfactory. A similar opinion applies to pharyngoscopy with the ingenious electric illuminator devised by Hays. In difficult and doubtful cases it may prove of decided utility.

In response to many requests a section on Diseases of the Ear has been added. The senior author considers himself fortunate in having enlisted the coöperation of Dr. Bryant, to whom he wishes to accord all credit and responsibility for the work done and views expressed in that department.

Finally the authors desire to make joint acknowledgment to their colleagues for helpful suggestions and to their publishers for the care with which their ideas have been executed. We owe especial thanks to Dr. Freer, of Chicago, and Dr. Jackson, of Pittsburgh, as well as to various surgical instrument makers for courtesy shown in permission to make use of certain illustrations. Many of those in the pages devoted to the ear are original and are now for the first time published. The volume is offered to the profession in the hope that it may be found a useful and reliable guide.

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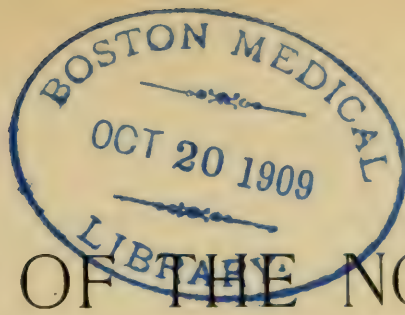
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DISEASES OF THE NOSE, THROAT AND EAR.

THE NOSE.

CHAPTER I.

ANATOMY AND PHYSIOLOGY OF THE NASAL PASSAGES. METHODS OF
EXAMINATION. INSTRUMENTS AND APPARATUS.

ANATOMY.

The nasal cavities are separated by a median partition, the septum, composed in front of cartilage and above and behind of bone—the perpendicular plate of the ethmoid, or mesethmoid, and the vomer. The shape and dimensions of the cartilaginous septum influence greatly the contour of the nose and the facial expression. This cartilage is quadrangular, its anterior margin forming the outline of the nose, and being joined in front to the lateral cartilages, which together form the alæ and tip of the nose. The nasal bones and the nasal processes of the superior maxillæ complete the framework of the external nose. The septal cartilage articulates above and behind with the anterior margin of the perpendicular plate of the ethmoid, below with the vomer and the bony ridge formed by the junction of the palatine processes of the superior maxillæ. We rarely, if ever, find the cartilaginous partition between the nostrils exactly vertical for two reasons. The prominence of the nose renders it particularly liable to blows and injuries, and the development of the cartilage frequently progresses long after the bones of the face have become consolidated, hence a bending or distortion of the cartilage results. In consequence we meet with a great variety of deformities of the cartilage which will be more fully considered elsewhere.

The posterior portion of the septum, being composed of bone and occupying a more protected situation, is relatively exempt from violence, so that we but seldom observe any displacement or asymmetry of the posterior margin of the vomer, no matter what degree of distortion of the septal cartilage may be present (Fig. 1).

The lateral cartilages are four in number, two on each side. Of these the lower have their anterior margins sharply recurved at their line of junction to complete the formation of the nasal septum, the partition between the anterior nares being called the *columna nasi*. The nasal fossæ extend from the nostrils or anterior nares in front to the posterior nares or choanæ behind and from the base of the

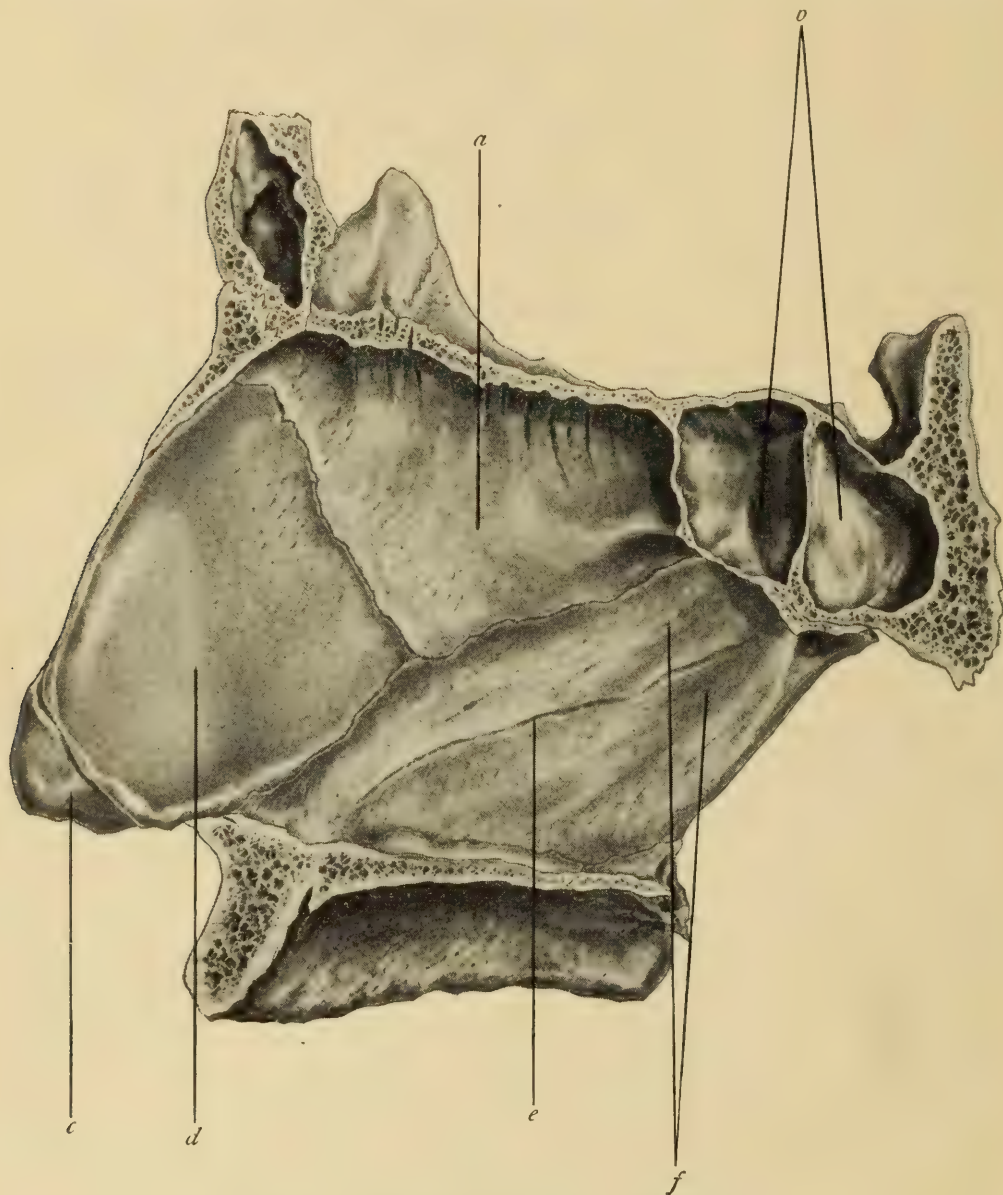


FIG. 1.—The Nasal Septum. (Deaver.)

a, Perpendicular plate of ethmoid; *b*, sphenoidal sinus; *c*, inferior lateral cartilage; *d*, septal cartilage; *e*, groove for nasopalatine nerve; *f*, vomer.

skull to the hard palate. They are wider below than above and are almost never symmetrical, owing to deformities of the septum or turbinate bodies.

On the outer wall of each nasal fossa may be found the nasal process and the inner surface of the maxillary bone, the lachrymal, the ethmoid, the palate, the inferior turbinate bones, and the internal pterygoid plate of the sphenoid. The roof of the fossa is bounded by the nasal bone, the nasal spine of the frontal, the cribriform plate of the ethmoid and the body of the sphenoid. The floor of the naris

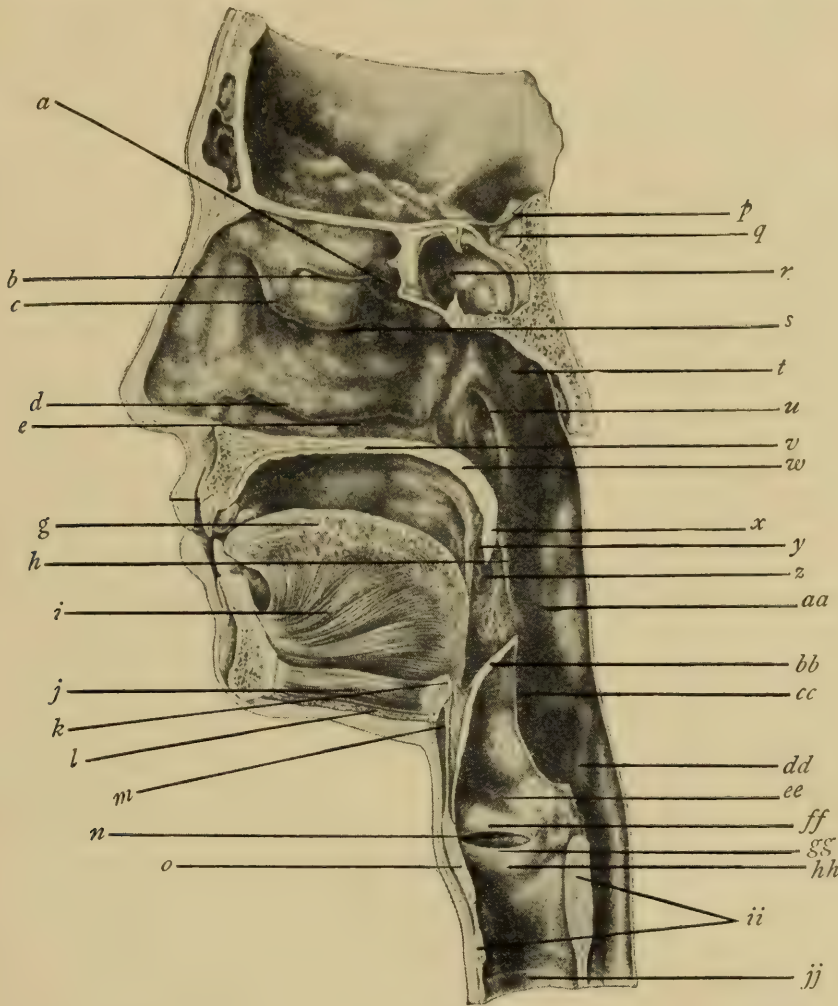


FIG. 2.—Outer Wall of Nasal Fossa, with Mouth, Pharynx and Larynx in Vertical Section. (Deaver.)

a, Superior meatus; *b*, superior turbinate body; *c*, middle turbinate; *d*, inferior turbinate; *e*, inferior meatus; *g*, tongue; *h*, posterior pillar of fauces; *i*, geniohyoglossus muscle; *j*, geniohyoid muscle; *k*, hyoid bone; *l*, mylohyoid muscle; *m*, thyrohyoid membrane; *n*, ventricle of larynx; *o*, thyroid cartilage; *p*, diaphragma sellæ; *q*, cavum sellæ; *r*, sphenoidal sinus; *s*, middle meatus; *t*, rhinopharynx; *u*, Eustachian orifice; *v*, hard palate; *w*, soft palate; *x*, uvula; *y*, anterior pillar of fauces; *z*, tonsillar fossa; *aa*, oropharynx; *bb*, epiglottis; *cc*, aryepiglottic fold; *dd*, laryngopharynx; *ee*, suprarimal portion of larynx; *ff*, ventricular band; *gg*, vocal band; *hh*, infrarimal portion of larynx; *ii*, cricoid cartilage; *jj*, tracheal ring.

is formed by the horizontal plates of the superior maxillary and palate bones. Each nasal cavity is partially subdivided by horizontal projections from its outer wall, the turbinate bones, which vary in

size and number in different individuals, and which with the soft tissues covering them constitute the turbinate bodies. They are frequently described as being "scroll-shaped." In other words, in the normal condition, their septal surface is convex and their under and outer surface is concave (Fig. 2).

Of these, the inferior is the only independent bone. The middle and superior are really processes of the ethmoid, as is likewise the fourth turbinate, or *concha suprema*, which is said to exist in about one in three or four specimens. The superior turbinate is practically a subdivision of the middle, with which it merges anteriorly. The turbinate bodies are of great interest and importance from a pathological as well as a physiological standpoint not only in themselves, but from the relation they bear to adjacent parts.

The inferior meatus is that portion of the nasal passage lying beneath the inferior turbinate body and has opening into it the nasal duct which conveys secretion from the lachrymal sac. The duct itself is half to three-quarters of an inch long and runs downward, backward and outward. Its nasal orifice, near the anterior end of the turbinate body, is protected by a fold of mucous membrane called the valve of Hasner. This membranous valve ordinarily prevents distention of the lachrymal sac, as by air in the act of blowing the nose, but recent observations have shown that fluids may pass through it from the nasal cavity. Several other valvular folds of mucous membrane in the course of the duct have been described.

Above the inferior turbinate and below the middle lies the region known as the middle meatus, into which open the passages from the antrum of Highmore, the frontal sinus, and the anterior ethmoidal cells. The most anterior is that of the frontal sinus, near the superior extremity of a crescentic furrow in the wall of the meatus known as the *hiatus semilunaris*, and usually just behind it is that of the ethmoidal cells. This part of the meatus including the orifices of the ethmoidal cells and of the frontal sinus is called the *infundibulum*. Sometimes the antrum, or maxillary sinus, has two openings.

The hiatus semilunaris runs obliquely downward and backward from near the anterior end of the middle turbinate, and lies below the *bullæ ethmoidalis*, an expanded ethmoid cell which projects into the meatus. The unciform process of the ethmoid, a thin plate of bone which articulates with the superior maxilla and with the inferior turbinate, and which enters into the formation of the nasal

wall of the antrum, forms the lower boundary of the hiatus semilunaris. The *ostium maxillare*, the larger and more constant orifice of the antrum, is situated at about the middle of the hiatus.

The space above the middle turbinate is called the superior meatus, into which open the posterior ethmoidal cells and the sphenoidal sinus. The orifice of the spheno-palatine foramen, covered by mucous membrane, is just above the posterior end of the middle turbinate body. At the line of articulation of the ethmoid with the nasal process of the superior maxilla near the anterior end of the middle turbinate appears a prominence on the outer wall of the fossa which has been described as the *agger nasi*. That portion of the fossa included by cartilage is called the vestibule of the naris, and is the only dilatable part of the passage, a point to be remembered in using the nasal speculum. The mobility of the alæ of the nose, which is very highly developed in some of the lower animals, is provided for by the insertion of a number of sesamoid and accessory cartilages between the lateral cartilages and the nasal processes of the superior maxillæ. To these, as well as to the cellular tissue at the margin of the nostril, muscular fibers are attached.

Two other points of interest in the septum should be referred to, the organ of Jacobson, which exists in man in the form of a *cul-de-sac* just within the nostril and above the floor of the nose, and the tubercle of Morgagni, or Zuckerkandl, a spindle-shaped aggregation of glandular tissue opposite the anterior end of the middle turbinate body, at the line of junction of the cartilage and the perpendicular plate. It has been suggested that the former may bear an important relation to perforations of the septal cartilage, which are frequently met with quite independently of syphilis, or other constitutional taint, while the latter when present in unusual volume may readily be mistaken for a pathological condition.

The floor of the nasal cavity is not flat, but slopes slightly downward and backward and is concave from side to side. The crest of the maxilla forms a considerable eminence just within the nostril, and behind it close to the septum is a shallow *cul-de-sac* indicating the situation of the duct of Stenson, which is marked in the mouth by the incisive papilla. The position of the anterior palatine canal, of which the duct is a subdivision, is important. Here the artery of the septum from the sphenopalatine, the terminal branch of the internal maxillary, anastomoses with the anterior palatine artery

from the descending palatine. Erosion or rupture of this arterial twig at the angle formed by the septum and the floor of the nose is a frequent source of epistaxis.

The pituitary membrane lining the nasal cavities, known as the Schneiderian membrane, is continuous with that of the accessory sinuses, with that of the orbits through the nasal ducts, and with that of the tympani through the Eustachian tubes. It is much thicker and more vascular over the lower part of the septum and the turbinate bones, especially the inferior, than elsewhere. The transition from integument to mucous membrane is very gradual. In the vestibule the mucous lining shows numerous vascular papillæ and is covered with squamous epithelium. Just at the nostril are a number of short hairs or *vibrissæ* which are intended to filter the inspired air. The epithelium of what is generally considered the respiratory region of the nose, or that part below the plane of the middle turbinate body, is columnar ciliated. The columnar epithelium lining the olfactory tract is not ciliated. The muciparous glands are tubular and of unusual length, extending through the entire thickness of membrane. In the olfactory region, besides the muciparous glands, we find tubular glands lined with round epithelium containing pigment, called Bowman's glands.

The direction of the inspiratory current is influenced by the shape and position of the nostrils and by the vigor of the act of breathing. Recent experiments indicate that even in quiet inspiration the air current does not pass directly backward along the floor of the nose, but describes an upward curve and passes more or less over the middle turbinate body. In expiration it is supposed to be deflected abruptly from the vault of the pharynx and pass out at a lower level.

The nerve of special sense of smell, the olfactory nerve, reaches the upper part of the nasal cavity through perforations in the cribriform plate of the ethmoid. It is distributed to the roof of the nose, to the superior and middle turbinate bodies and to the opposite surface of the septum. The terminal filaments of this nerve, just before reaching the surface of the mucous membrane between the epithelial cells, present fusiform expansions called the olfactory cells of Schultze. The subdivisions of the olfactory nerve, upward of twenty in number on each side, are invested with a coat from the dura mater and are said to differ from other cranial nerves in containing

no white substance of Schwann and in having axis-cylinders with a distinct nucleated sheath which presents few and separated nuclei.

The sensory nerves of the mucous membrane are derived from the fifth pair. Filaments from the external division of the nasal branch of the ophthalmic and from the Vidian supply the roof. The outer wall receives filaments from the superior nasal branches of the spheno-palatine ganglion, from the nasal, from the inner branch of the anterior dental and from the inferior nasal branches of the large palatine nerve. The septal branch of the nasal nerve, nasal branches of the spheno-palatine ganglion, the naso-palatine, and the Vidian are distributed to the septum. The floor is supplied by the naso-palatine and the inferior nasal branches of the large palatine nerve.

The arteries of the nasal cavities are derived from the anterior and posterior ethmoidal branches of the ophthalmic, which supply the roof of the nose, the anterior and posterior ethmoidal cells and the frontal sinuses; from the nasal artery of the internal maxillary, which supplies the septum, the meatuses, and the turbinate bodies; from the posterior dental branch of the internal maxillary, which supplies the antrum (Holden). The veins, which accompany the arteries, communicate with the intracranial veins through the foramina in the cribriform plate, as well as through the ophthalmic vein and the cavernous sinus.

The mucous membrane covering the turbinate bones has a peculiar structure demanding special description. Its spongy character has long been recognized, and fifty years ago Cruveilhier defined it as true erectile tissue. Later Kohlrausch, Bigelow and others made careful anatomical studies of this tissue, and still more recently the exhaustive investigation of Zuckerkandl established the existence of so-called "turbinated corpora cavernosa." It seems that the deep layer of the mucous membrane forms the periosteum. Distributed freely through the connective tissue of the membrane are lymph tissue and tubular mucous glands of extraordinary length. Within the lymphoid tissue are numerous venous sinuses surrounded by an abundance of unstriped muscular fiber. The "erectile tissue" thus constituted is subject to rapid and extreme variations in its dimensions under the influence of atmospheric conditions and of mechanical irritation, as well as of mental emotions. In dry air these bodies retract, in a humid air they swell. When this process of retraction and expansion has been too frequently repeated a condition of vaso-

motor paresis becomes established, which results in more or less permanent enlargement of the turbinate body, with consequent nasal stenosis. This is the first stage of what will later be described as hypertrophy.

The accessory sinuses, which are supposed to contribute to the resonance of the voice, to diminish the weight of the skull and to afford protection to the nerve centers, are four in number on either side; the maxillary sinus, or antrum of Highmore, the frontal sinus, the ethmoidal sinuses, usually called cells, and the sphenoidal sinus. Of these, the largest is the maxillary sinus, which is a cavity in the superior maxilla bounded above by the floor of the orbit, within by the outer wall of the nasal fossa, and below by the roof of the mouth, its floor therefore being considerably below its normal outlet, which is found in the middle meatus. The frontal sinus lies between the tables of the frontal bone, the roof of the orbit forming its floor. A more or less complete median partition usually separates the frontal sinus into two parts. It also opens into the middle meatus near the orifice of the anterior ethmoidal cells. The sphenoidal sinuses are two excavations in the body of the sphenoid bone sometimes divided by a vertical septum, but frequently communicating so as to form a single cavity. The ethmoidal cells, as their name denotes, are multiple cavities in the body of the ethmoid, separated by thin bony plates and arranged in two groups, anterior and posterior, the former opening into the middle, the latter into the superior meatus. The nasal orifices of the maxillary and frontal sinuses, and of the anterior ethmoidal cells, are in close proximity, and it has been shown that secretions from the frontal sinus may drain into the antrum and give many of the symptoms of antral disease. The clinical importance of this fact is very great, since opening the maxillary sinus under such circumstances would of course be entirely futile. Not infrequently the posterior ethmoidal cells open into the sphenoidal sinus, and the latter sometimes communicates with the antrum. The anatomical relations of the accessory cavities and the variations from their normal arrangement are thus seen to be sources of difficulty in positively identifying sinus disease.

PHYSIOLOGY.

The nose is the organ of the special sense of smell, but its more important duties relate to the acts of respiration and phonation, it

being so constructed as to warm, moisten and filter the inspired air. We may remain in comparative comfort without the ability to detect odors, but complete, or even partial, stenosis of the nostrils is a serious impediment to health. It is merely necessary to cite the familiar example of an individual with "a cold in the head" to indicate the importance of unobstructed nasal passages to the production of a clear and resonant voice. Olfaction, respiration and phonation are therefore all more or less affected by morbid conditions in the nasal chambers.

The sense of smell resides in the upper part of the nasal cavity, the olfactory nerve being distributed as low down as the middle of the middle turbinate body and the opposite surface of the septum. It is essential that odoriferous particles should reach this region, that the mucous membrane should be healthy, and that the nerve supply should be unimpaired. Otherwise the sense of smell may be lost, a condition known as *anosmia*. An interesting perversion of the sense of smell, the subjects of which perceive an odor not present, is called *parosmia*, and is undoubtedly a neurosis. It is sometimes regarded as a precursor of mental alienation. Precisely how odors are appreciated is a matter of theory. Mechanical irritation of the nerve filaments in the pituitary membrane, oxidation of odoriferous particles, molecular vibration, the heat-absorbing power of different materials, and finally the pigment-secreting quality of Bowman's glands have all been suggested in explanation of the function. A theory of the sense of smell recently propounded maintains that it is not due to contact of odoriferous particles with the nasal membranes, but to rays analogous to those of light, heat and the Roentgen-ray (Vaschide and v. Melle). The important degree to which the sense of smell contributes to our pleasure may be realized when we recall the limitations of the sense of taste, all flavors, with the exception of acid, bitter, sweet and salt, being recognized only through the olfactory nerve. The keenness of this sense depends in part upon the extent of the olfactory membrane. For this reason, the turbinate bodies in some of the lower animals are extraordinary in shape and dimensions. It is also said that its acuteness may be developed by practice.

The inhalation of air at an unsuitable temperature, of an excessive degree of dryness, or laden with impurities is a source of irritation to the lower air passages and sooner or later of disease. Numerous

experiments have been made in order to determine the increase in temperature and saturation which the inspired air undergoes in its transit through the nasal passages. It has been demonstrated that by the time the air reaches the pharynx through a normal nose, whatever the degree of external cold, it has become almost or quite as warm as the blood, and at the same time has become saturated with moisture, however dry the atmosphere may be. The interesting fact has also been established that the nose supplies to the expired air a small proportion of carbonic acid, estimated at about one-fiftieth part of that contributed by the lungs. An examination of an individual exposed to a dust-laden atmosphere is sufficient to satisfy one of the extent to which foreign bodies in the inspiratory current are detained in the nasal fossæ. In view of its complex functions it is easy to understand the importance of a normal nose, not necessarily a nose with perfectly symmetrical turbinate bodies, or with a septum absolutely smooth and vertical, but one capable of conveying to the lungs an adequate supply of pure air of proper quality.

The resonance and timbre of the voice are markedly influenced by the shape and size of the nasal cavities, and an agreeable quality is given it by the formation within the nasal chambers of those secondary vibrations to which has been given the name, "over-tones."

An attempt has been made to draw conclusions as to the site of intra-nasal lesions from the varying impressions they produce upon the quality of the voice, but we find it impossible to go farther than to say that stenosis of the anterior nares merely diminishes the resonance of nasal sounds, which is retained in a measure so long as the naso-pharynx remains normal. The so-called "dead voice" of the condition known as adenoids in the vault of the pharynx is an example of absolute loss of resonance.

EXAMINATION AND INSTRUMENTS.

The first essential to satisfactory examination of the upper air-passages is a good light. Sunlight may be utilized by means of a system of mirrors, but is not always to be had, and for the sake of convenience we resort to artificial sources of illumination. A German student oil lamp, fitted with a Mackenzie condenser (Fig. 3),

answers the purpose, but the Argand gas burner is better. The electric light is at our service and various head lights (Fig. 4) and lamps for use within the condenser have been devised. One of the best lights proposed, up to the present time, is what is known as the improved Welsbach light, which consists of a gauze network, chemically prepared, and placed over the Argand flame. This network, or mantle, is rather delicate and must be handled carefully, but when protected by a mica chimney and the bullseye condenser, will burn upward of 1,000 hours and gives a very beautiful white light. The mantel may be renewed at trifling cost, and the original outfit is inexpensive. Having secured a good light, we next seek to reflect it upon the parts to be examined. In the

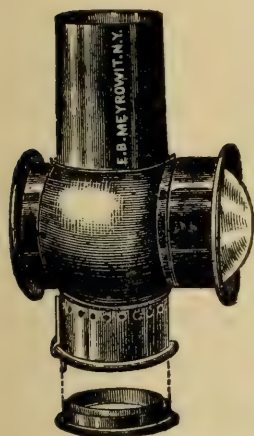


FIG. 3.—Mackenzie's Light Condenser.



FIG. 4.—Kuttner's Electric Head Light.

more elaborate apparatus, as Tobold's, the reflector is attached to the lamp. It will be found more convenient, however, to wear the reflector upon the forehead. A concave glass mirror, 3 1/2 inches in diameter, with a focal distance of about 16 inches and framed in aluminum is attached to a Pomeroy forehead piece and held to the head by means of a band of leather or silk braid, an inch in width. It is very light, and worn indefinitely with comfort, and is to be preferred for operative work and when one has a large number of patients to examine successively.

In all examinations of the nose and throat let the source of light be on the right of the patient, so that the right hand of the examiner, with which most of the manipulating is usually done, may not interfere. The examiner should sit facing his patient with his

knees separated, one on either side of the patient's knees. The position advocated by some, with the knees of the examiner together and on one or the other side of the patient, may be a gain in elegance, but is a sacrifice of steadiness, a point of importance in operating. The head mirror should be worn over the left eye in such a way that both eyes are brought into service. After a little experience one knows instantly whether binocular vision is obtained. At first an easy way to settle the question is to close the right eye and if then the open left eye looking through the aperture in the center of the head mirror includes the whole circle of light thrown at the focal distance

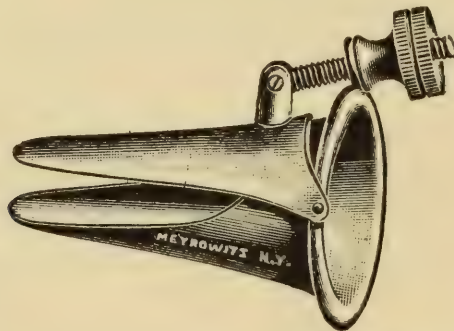


FIG. 5.—Duplay's Nasal Speculum.

by the reflector, one is sure of using both eyes. On very close inspection of points in the depths of the nasal fossæ only one eye at a time can be used. It is well to have all the instruments to be brought in contact with the patient comfortably warmed. In the case of throat mirrors this is indispensable in order to obviate condensation of moisture upon the glass. The mirror should be warmed by holding it face down, over the gas flame for a few seconds, and the degree of heat should be tested on the ball of the examiner's thumb before the mirror is placed in the throat. Nothing so unnerves a timorous patient, aside from general awkward management, as the touch of an excessively hot mirror.

Inspection of the nasal and naso-pharyngeal cavities is called *rhinoscopy*. By *anterior rhinoscopy* we discover the condition of the cartilaginous septum, the floor of the nose, and the anterior ends of the middle and inferior turbinate bodies. This procedure is very much facilitated by preliminary spraying of the nares with a 4 per cent. solution of cocaine. The indiscriminate use of cocaine, however, should not be encouraged, and it never should be used until we have first seen the parts in the natural state. We study

the posterior nares and the naso-pharynx by means of small mirrors introduced into the oro-pharynx, or *posterior rhinoscopy*.

A good nasal speculum in *anterior rhinoscopy* is almost as necessary as good illumination. The ideal speculum should be easy of



FIG. 6.—Hartmann's Nasal Speculum.

manipulation, give the patient no discomfort, and be capable of admitting a generous flood of light as with the Duplay speculum (Fig. 5). Its solid blades have the double advantage of exerting uniform diffuse pressure and pushing aside the vibrissæ,

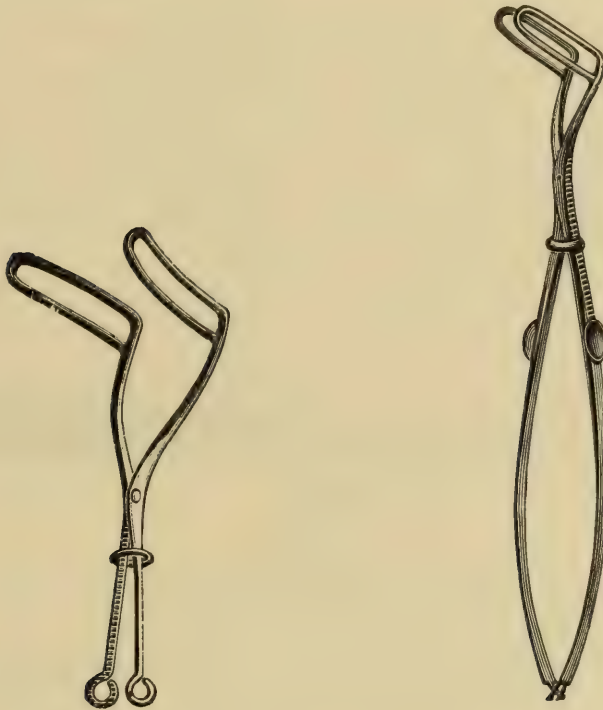


FIG. 7.—Jarvis' Nasal Specula.

which grow so profusely in the nostrils of some patients, and which are apt to protrude through the opening of a fenestrated speculum and impede the rays of light. Hartmann's speculum is also a very convenient instrument (Fig. 6). The walls of the nasal vesti-

bule are but slightly dilatable, hence the importance of using a speculum the separation of whose blades may be regulated at will. All fenestrated instruments, with uncontrolled springs, are to be condemned. In operating far back in the nasal cavity the Jarvis speculum (Fig. 7) is more convenient, since it is lighter and self-retaining, and is less apt to get in the way of the operator.

No rhinoscopic examination should be considered complete until inspection of the mucous membrane has been supplemented by pal-

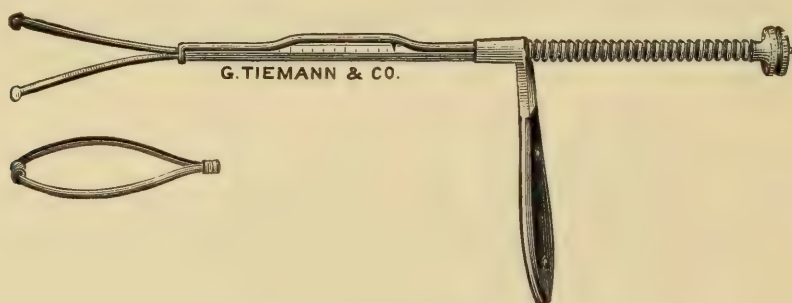


FIG. 8.—Jarvis Rhinometer.

pation with the probe. We thus gain information as to the vascularity, the density and mobility of the structures normal or morbid. It is also frequently important to determine the sensitiveness of the pituitary membrane, or to define areas of suspected hyperesthesia. If still more exactness is desired, we may measure the width of the nasal passages at various points by means of Jarvis' rhinometer, or the thickness of the septum with Seiler's septometer



FIG. 9.—Seiler's Septometer.

(Figs. 8 and 9). The roof of the nose and the region of the openings of the posterior ethmoidal cells and of the sphenoidal sinus may be exposed by *median rhinoscopy* (Killian). The middle turbinate body can be pushed aside by means of a long-bladed speculum passed between it and the septum. The method is not very painful after the free use of cocaine and is of occasional service in determining the source of suppuration in doubtful cases.

In *posterior rhinoscopy* we frequently have to contend with various obstacles, such as a rebellious tongue which resents the pressure of the tongue spatula, an irritable pharynx whose muscles contract in the act of gagging almost as soon as the mouth is opened, an unusually narrow space between the palate and the pharyngeal wall, or persistent elevation of the velum during an attempt to illuminate the posterior nares. In many cases we succeed in getting a view only by the exercise of the utmost tact and patience, and our subject may have to be put through a course of training for several

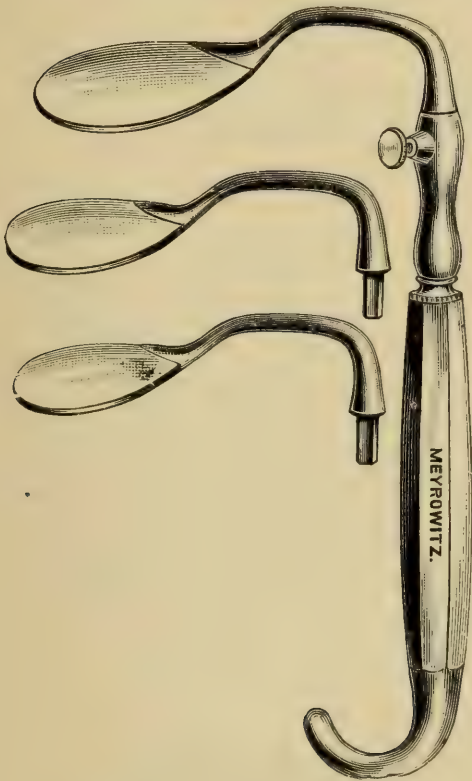


FIG. 10.—Türk's Tongue Depressor.

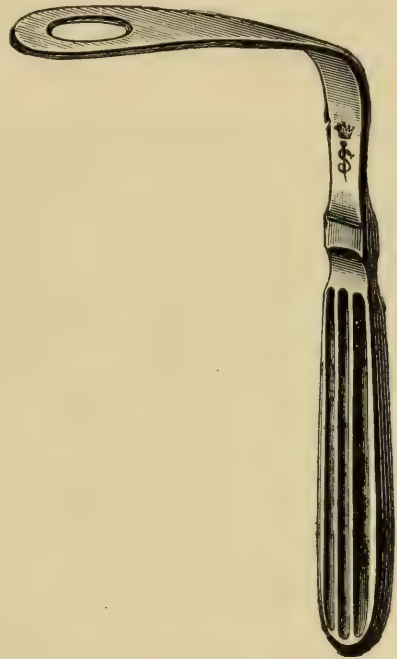


FIG. 11.—Bosworth's Tongue Depressor.

weeks before giving more than a glimpse of the parts we wish to explore. The tongue should never be roughly handled. A Türk depressor with a smooth tongue piece, held in the examiner's left hand, should be applied to the middle of the dorsum of the tongue not too far back and steady, firm pressure made in a downward direction (Figs. 10 and 11). The rhinoscopic mirror, No. 1, or larger in trained subjects, properly warmed, is then introduced face upward to the right of and behind the uvula, care being taken to avoid sudden and rough contact with the wall of the pharynx.

The patient is directed to breathe quietly meanwhile through the nose. By gently raising or lowering the right hand which holds the mirror and by slightly rotating the shaft without shifting the mirror about in the fauces, the examiner will finally get all the details of the rhinoscopic image. It is rarely possible to use a mirror large enough to give a complete picture.

Irritability of the pharynx may usually be overcome by frequent repetitions of examination from day to day. Attempts at the first



FIG. 12.—White's Palate Hook.

sitting should be abandoned in case there is found to be extreme sensitiveness. We succeed in establishing tolerance by directing the patient to pass his forefinger far back upon the dorsum of the tongue and over the velum several times a day, thus accustoming the pharynx to the presence of a foreign body. The patient may hold small pieces of ice in the mouth for fifteen minutes before examination, or if the necessity is urgent, we may spray the pharynx with a four per cent. cocaine solution. Cocaine may defeat us



FIG. 13.—Kyle's Postnasal Electric Lamp.

by the nausea which it excites in certain individuals. It should be used for purposes of examination only as a last resort, and the patient should always be warned of the discomfort it is likely to cause. In some cases assistance is gained from the use of a palate hook by which the velum is held forward. One of the most convenient is White's (Fig. 12), which has been modified by dispensing with the joint in the shaft and adjusting a rubber band, so as to make the instrument automatic. For ordinary use it is not to be recommended, since we find that it is most easily applied in those

tolerant throats which permit a satisfactory examination without it. Yet in certain rare cases of doubtful diagnosis, or in which the electric cautery is to be used in the naso-pharynx, it is serviceable. After an application of cocaine it is borne without objection.

A thickened or elongated uvula, or hypertrophied palatal tonsils add more or less to the difficulties of a posterior rhinoscopy, but they are seldom insurmountable.

A small electric lamp fixed at a right angle to a suitable handle passed behind the velum gives an excellent illumination of the pharynx as well as of the nasal cavities. After the patient has learned to keep the lamp in place with the closed lips a good view is obtained by looking through the anterior nares. Such a lamp as that devised by Kyle (Fig. 13), which is protected by a movable aluminum cap, produces little or no discomfort by the evolution of heat.

Digital examination of the naso-pharynx is a procedure too much neglected. It is by no means agreeable to the patient, but it is done quickly, and it is well for the student to familiarize himself with the landmarks of this region by the sense of touch. In young children, and in those who will not tolerate rhinoscopy, it is the only way by which a knowledge of the extent and disposition of lymphoid hypertrophies can be gained. In practising this method in young subjects the finger is protected by a jointed metal shield, or a piece of elastic rubber tubing, or the following course is adopted. The child is held in the lap of the mother, or of an assistant, who controls its hands. The examiner then standing on the child's left presses his right middle finger upon the patient's right cheek, at the same time bringing its head against his own body. The firm pressure causes the child to open its mouth, when at once the examiner's left forefinger should be passed into the pharynx. The pressure being maintained the cheek is pushed between the teeth of the open mouth, and the examining finger is safe, since the child cannot close its jaws without biting its own cheek.

CHAPTER II.

ACUTE AND CHRONIC RHINITIS.

Inflammation of the mucous membrane lining the nasal passages, or *rhinitis*, may be *acute* or *chronic*. The phenomena of chronic rhinitis are so complex and its complications and consequences so varied as to demand extended description.

The symptoms of acute rhinitis, or coryza, are familiar and need but little attention. The majority of people have a "cold in the head" from time to time, think it of slight consequence and let it run its course. It is certainly worth while, however, to consider the causes of "catching cold" and the measures adapted to its prevention and relief. In addition to individual proclivity based upon a diathetic condition, there are certain local structural changes and relations within the nasal fossæ which make one particularly liable to catch cold. Moreover, we all recognize the fact that occupations which involve exposure to frequent and abrupt changes of temperature or to irritating vapors increase the liability. The nerve theory of etiology is maintained by some. A neurotic element is no doubt often prominent and the predisposing influence of depressed general health is beyond question. It is undeniable that a general atmospheric state sometimes exists which leads to the development of a pandemic of acute rhinitis. Under such circumstances there is a natural suspicion of contagion, but as yet we have no positive proof that rhinitis is thus transmitted. Some of the causes immediate and remote are avoidable, and it is equally true that the course of the disease may be cut short by appropriate treatment. Many of the more serious and distressing chronic affections of the nose have their origin in a neglected cold in the head.

Prophylaxis is a far more important function of the physician than drug giving. The question of ventilation, especially of sleeping-rooms, and the matter of quality and kind of underclothing are subjects by no means beneath his notice. They certainly have a most serious bearing upon the susceptibility of a patient to cold from exposure. We all know the danger of sudden chilling of the surface

when overheated. We think less of the ill effects of superheated foul air in our homes and places of amusement. The use of cold water as a means of toughening the cutaneous surface is highly estimated and perhaps justly, but many of its enthusiastic advocates lose sight of the depressing effect it may have upon the general system. By judicious hints as to points of hygiene, dress and diet, it is doubtless possible to prevent many of the catarrhal affections which are so difficult to cure. How far climatic influences are factors in the causation of "catarrh" it is difficult to say. A similar observation is true of the tobacco and alcohol habits. It is not unusual to hear a patient say that he never has trouble except when he comes to New York, while the next visitor may remark that he is never so comfortable elsewhere. One patient will affirm that tobacco and alcohol invariably aggravate his catarrhal symptoms, while the next, an inveterate smoker, will express his belief that tobacco has preserved his health. It seems to be impossible to lay down an arbitrary rule on these points. They are matters of individual experience. In general it may be said that the excessive use of these luxuries is harmful. What constitutes excess depends upon temperament, occupation and general habits of life. Moderation in one may be excess in another. The relationship between sexual excitement and turgescence of the nasal erectile tissue is obvious and sexual excess must be included among the factors in the etiology of rhinitis.

As to the propriety of the term "catarrhal diathesis," which is sometimes used to indicate a propensity to inflammation on the part of the mucous surfaces generally, it is reasonable to assume the existence of a constitutional condition which influences the vital resistance and functional activity of the mucous membranes as well as of other tissues and organs of the body.

In the first stage of an acute rhinitis, the mucous membrane is abnormally dry and the patient is conscious of some obstruction to nasal breathing. Sneezing, lachrymation, more or less frontal heaviness, or actual headache, with a feeling of general lassitude and depression, comprise the usual train of symptoms. If the inflammatory process actually extends to one or more of the accessory sinuses, which, fortunately, rarely happens, there is more decided pain, neuralgic in character. There is generally more or less congestion of the sinuses associated with an acute rhinitis, and especially in the frontal region there may be complaint of sensitiveness and a feeling of

tension. The sense of smell is completely abolished for the time being. One of the most annoying symptoms is *tinnitus aurium*, frequently accompanied by impairment of hearing and a sense of fullness in the ears, dependent, no doubt, upon extension of the inflammatory process to the naso-pharynx and the orifices of the Eustachian tubes. There may be a mild degree of pyrexia. In the course of a few hours the dryness of the membranes is succeeded by an effusion of watery secretion, more or less profuse, at first mucous and gradually becoming purulent. In the declining stage the discharges become thicker and dryer. If inspected in the prodromic stage the mucous membrane is seen to be excessively tumefied, dry and glazed, and very red. In the second stage the swelling and redness may persist, but the surfaces are bathed in mucus. In the final stage we find the congestion and swelling less, but the nasal passages are apt to be obstructed by tenacious purulent and inspissated secretion. Usually in a week or ten days the patient is restored to health, but not without perceptible aggravation of a preëxisting abnormality, or certain changes in the tissues which increase the tendency to recurrent attacks.

Treatment.—An attack of acute rhinitis may be invariably mitigated and sometimes aborted. At the outset it is customary to give to an adult ten grains of quinine with ten grains of Dover's powder, and proportionate doses to children, unless there is some known contra-indication. By many this course is strongly opposed. Measures tending to encourage perspiration are often used with benefit, such as the hot foot bath and hot lemonade internally. Some observers insist upon entire abstention from fluids internally, with the result, it would seem, of adding rather to the patient's discomfort. On the other hand, Cohen recommends copious draughts of water. The less local meddling the better, but there seems to be no doubt that an application of cocaine, two per cent. to the inflamed nares, followed by an insufflation of Ferrier's snuff (morph. sulph. gr. i, bismuth. subnitr. \mathfrak{Z} iii, pulv. acacia \mathfrak{Z} i) is very soothing and contributes to the comfort of the patient (Fig. 14). Cocaine should never be entrusted to a patient except in extreme cases and unless we are quite sure of his capacity to resist the fascinations of the habit. The abuse of an agent, so energetic and decided in its action, may do permanent harm. There is no doubt about the comfort it gives by emptying the venous sinuses and thus restoring

the caliber of the nostrils, but its effects are transitory, and the temptation to resort to it again and again is almost irresistible. The promiscuous recommendation of cocaine is, therefore, dangerous and should be discountenanced. A solution of cocaine alkaloid, 2 per cent. in equal parts of almond and petroleum oil has been found by Wyatt Wingrave to give more prolonged results though acting somewhat more slowly than a watery solution. A 5 per cent. watery solution of cocaine hydrochlorate, containing 2 per cent. sodium sulphate, proved to give as complete effects as much stronger solutions of cocaine alone. Thus the danger of toxic symptoms is much reduced

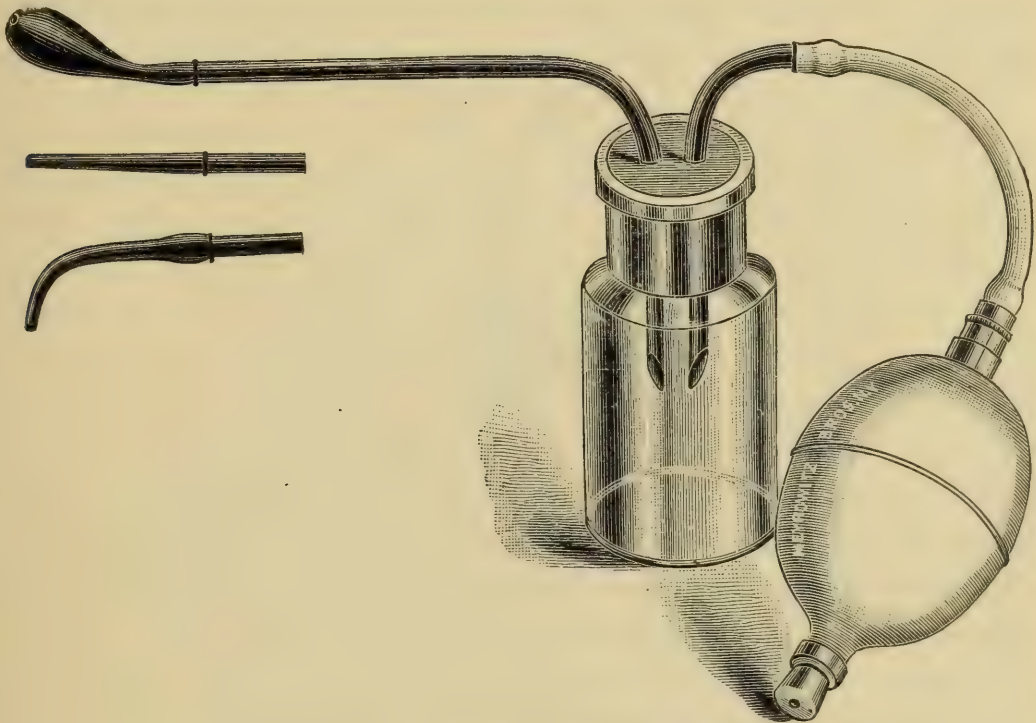


FIG. 14.—Universal Powder Blower.

and moreover the combination is more rapid in its action. The inhalation of a vapor of camphor and menthol (5 grs. of each to one ounce of fluid albolene or benzoinated albolene) usually gives temporary relief and may be safely repeated at short intervals. The patient may be instructed to inhale from a wide-mouthed bottle containing equal parts of powdered camphor and menthol to which a few drops of ammonia have been added. The famous Hager-Brand remedy (acid. carbol. \mathfrak{Z} i, alcohol \mathfrak{Z} iii, aq. ammon. fort \mathfrak{Z} i, aq. distill. \mathfrak{Z} ii) is used in a similar way, or is sprinkled on a handkerchief and inhaled. Many drugs of this class are satisfactorily inhaled from a nebulizer or vaporizer (Fig. 15).

A combination, the value of which has been somewhat exaggerated, for controlling secretion and reducing the turgescence of the erectile tissue, is a tablet (rhinitis tablet) containing one-eighth of a minim of belladonna fl. ext. and one-fourth grain each of camphor and quin. sulph. to be given half hourly until ten or twelve have been taken or the patient becomes aware of a feeling of dryness in the pharynx. In malarial cases quinine is indicated. In rheumatic and gouty subjects the salicylates and antilithics are of service. In this connection it is of interest to note the alkaline treatment of a "cold in the head," as advocated by Bulkley, who gives bicarbonate of soda in full and frequent doses. The necessity of treating a rhinitis complicating the exanthemata in children by means of cleansing and



FIG. 15.—The DeVilbiss Invertible Nebulizer.

germicidal solutions should be appreciated. The relative importance of general symptoms sometimes leads to neglect of the local conditions with disastrous results. Space does not permit reference to numerous other remedies, local and general, most of them of indifferent value, with the exception of adrenal extract, to be referred to in the section on hay fever, and of hourly insufflations of orthoform, either pure or combined with sodium sozoiodolate, as confidently recommended by Spiess. The use of the latter is based on the neuropathic theory of causation, and the applications are said to be more effective if made through the mouth to the vault of the pharynx. In conjunction with the local treatment various drugs classed as antineuralgics or nervines are given internally.

In a small proportion of cases recovery from a course of acute rhinitis does not ensue and we have established a condition of *chronic rhinitis*, known to the public and to many general practitioners as "catarrh."

For the sake of simplicity, we may divide chronic rhinitis into three varieties, *catarrhal*, *hypertrophic* and *atrophic*, basing this subdivi-

sion upon the clinical phenomena characteristic of each. Several other forms, comparatively rare and named from certain prominent symptoms, will be described.

In chronic *catarrhal rhinitis* hypersecretion is the principal symptom. The patient soils many handkerchiefs during the day and is constantly annoyed by the accumulation of secretion in the postnasal space. Nasal respiration is not perceptibly impeded, or the patient may complain of intermittent stenosis alternating between the nostrils. We have here, then, an early sequel of an acute process which involves mainly the glandular elements of the mucous membrane, but which will sooner or later develop structural changes of a hyperplastic character.

In the latter case, *hypertrophic rhinitis* supervenes, the main feature of which is persistent continuous obstruction to nasal breathing. The secretions are still apparently in excess. As a matter of fact, their proportion is reduced, but their quality is so perverted and the changed conditions so prevent their normal disposition, that they accumulate in the nasal chambers until removed by violent efforts at expulsion. The attempts at clearing the pharynx, especially in the morning, are often very distressing. These patients are habitual mouth breathers and snorers, and are apt to waken from sleep in the morning with the mouth and tongue dry and parched. Disorders of digestion are not infrequent, attributed perhaps unjustly to putrid and decomposing secretions finding their way from the pharynx to the stomach. The larynx may be affected and the voice becomes hoarse in consequence of the inspiration of improperly prepared air, the function of the nose being entirely or in part suspended. Among the more annoying, and at times painful symptoms of hypertrophic rhinitis, may be mentioned various reflex disturbances resulting from intranasal pressure. This subject has been actively investigated in recent years and many interesting phenomena have been discovered. It has been clearly demonstrated that very many functional disorders of the eye and notably of the ear are due to a point of irritation or pressure within the nose. Facial neuralgia, frontal headache, cough and derangements of the voice may be attributable to a similar cause. The relief to ear symptoms following intranasal operations is sometimes very striking. Unfortunately, in many cases the aural difficulty has passed the line of purely functional disturbance before a nasal lesion is sought for or suspected. While it must be admitted

that chronic turgescence of the turbinate erectile tissue and other nasal lesions may induce changes in the function and structure of various organs, we must avoid the error of assuming that all human ills have a nasal origin.

It is difficult to fix a line which separates the varieties of chronic rhinitis. The pathological processes merge into each other by such slow gradations that we frequently find several of them represented in the same subject. One nostril may be blocked by hyperplasia, while the other is widely expanded in an advanced stage of atrophy.

The diagnosis of an established case of atrophic rhinitis is usually easy, but the difficulty of identifying the two varieties of chronic

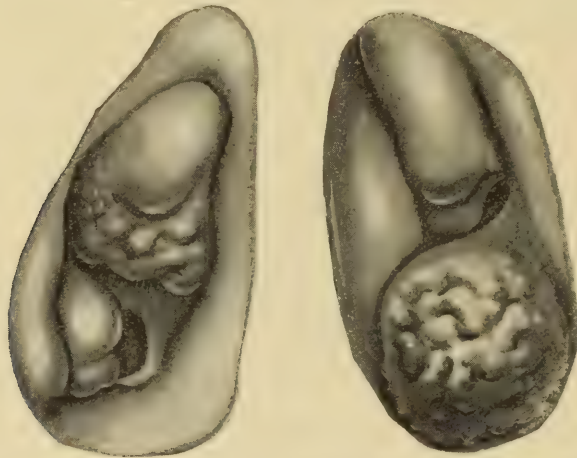


FIG. 16.—Lobulated Hyperplasia of Left Inferior and Right Middle Turbinate. (*Grünwald.*)

rhinitis which have been described is greater. We rely upon inspection, touch with the probe and cocaine to differentiate them.

The first (hyperemia) presents a red tumefaction of the turbinate bodies, of uniform smoothness, which is quite sensitive and bleeds freely. It yields to compression with a probe, and in the early stages the pressure being released the tumor instantly reforms, owing to reëngorgement of the erectile tissue. Later on when vasomotor paresis occurs the furrow caused by the probe is more lasting. The swelling promptly subsides under cocaine. In the second form (hyperplasia) the tumor is paler in color, irregular in contour, and less sensitive and vascular. Frequently, it is distinctly lobulated, papillated, or even fimbriated (Fig. 16). It is manifestly more dense in structure, is compressed only by very firm pressure with the probe, and resumes its original shape very slug-

gishly. It does not completely shrink after an application of cocaine.

In deciding upon a course of treatment it is important that we should distinguish these conditions. In the former case, sedative applications, mild astringents perhaps, and the correction of vicious habits, notably the pernicious practice of violent nose blowing, will suffice. In the latter we have to deal practically with a foreign body which must be removed.

Vasomotor paresis of the walls of the blood-vessels composing the erectile tissue of the turbinate bodies is a prominent feature of the transition stage of hypertrophy. A physiological process thus gradually becomes pathological and the muscular walls of the venous sinuses undergo degeneration in consequence of which they remain permanently dilated until compressed and obliterated by the surrounding new connective tissue. This constitutes what is sometimes described as a "turbinal varix," seen usually at the posterior end and lower border of the inferior turbinate. Not infrequently, the osseous structures themselves become implicated in the inflammatory process, or undergo enlargement as a result of hypernutrition. A most interesting series of pathological changes ensues involving chiefly the middle turbinate bone, which until recently has received but little attention. The bone may be simply thickened, or it may undergo a process of cystic formation or expansion. The inferior turbinate is but seldom thus affected, whereas in the case of the middle turbinate the discovery of these osseous cysts is a common occurrence. Their development is explained in various ways. In the majority of cases it doubtless results from a rarefying osteitis inducing absorption of the interior of the body of the bone. In other cases the cyst is believed to be due to the prolongation of an ethmoid cell into the body of the middle turbinate and its subsequent expansion.

The developmental theory of etiology is accepted by Payson Clark, who professes to have found no evidences of inflammatory action in four cases of *concha bullosa* operated upon by himself, and who has discovered in literature only four cases accompanied by pus formation. On the other hand J. Wright points out the presence of osteoblasts building up bone on the outside of these cysts while osteoclasts are absorbing it within. Thus a preëxisting cavity becomes larger and larger as a result of a low grade of osteitis. These

cysts are very common, Zuckerkandl having found them thirty-six times in 200 post-mortem observations. They are generally met with in adults and are more frequent in women than in men.

The cyst sometimes reaches enormous dimensions, as shown in the accompanying plate (Fig. 17). The mucous membrane covering it may persist in its hyperplastic condition, may become polypoid, or may atrophy. It is perhaps more usual to find it in the last mentioned state. The tumor might readily be mistaken for a polyp or an ordinary hypertrophy unless carefully examined with a probe, when its hardness and immobility are detected. Often the bony

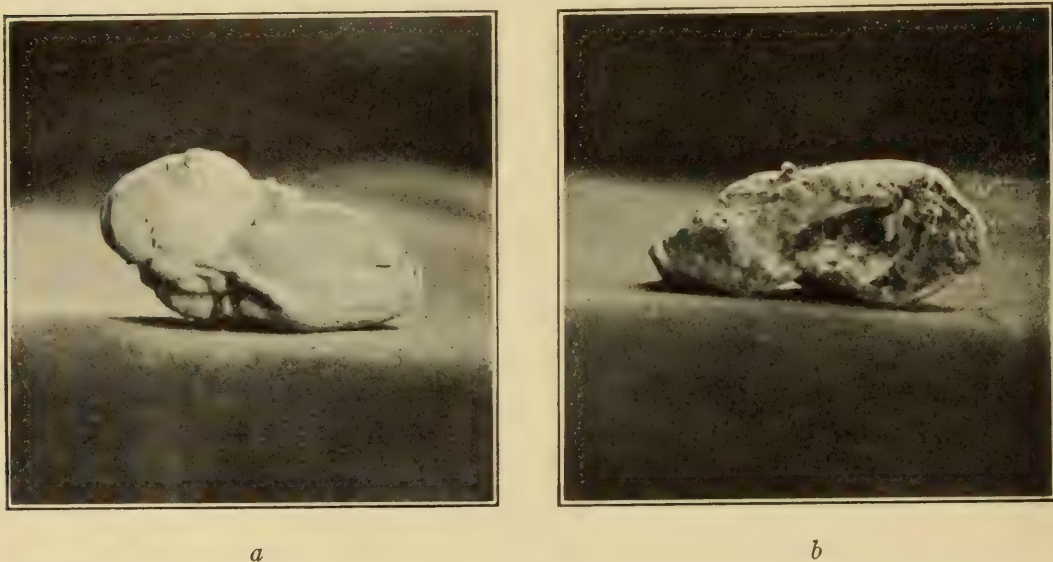


FIG. 17.—Cyst of Middle Turbinate Bone. (Author's specimen.) *a*, Nasal surface; *b*, interior of cyst.

shell forming the wall of the cyst is so thin as to be readily punctured with a sharp probe (Fig. 18).

Treatment.—In the early stages of chronic rhinitis we should endeavor to soothe the irritated mucous membrane and to reestablish its normal functional activity. The warning against hasty and too free use of destructive agents at this period cannot be repeated often enough. In our clinics many patients are met with who can distinctly trace their condition of incurable atrophy to excessive zeal in the use of caustics. Some, at least, of these might have been saved by mild measures, and by attention to the general health and mode of life. It may prove to be necessary to cauterize, but before doing so in any case in which we cannot clearly define areas of hyperplasia,

we should see what may be accomplished by diligent use of alkaline and antiseptic sprays or douches. Fluid applications may be made to the nares by means of an atomizer (Fig. 19), or of one of the various nasal douches (Fig. 20), cups or syringes (Fig. 21). The spray tubes made of very thick glass, in one piece, and with blunt tips, are entirely satisfactory (Fig. 22). Three styles are needed, up, down, and straight. The first two should be five inches in length,

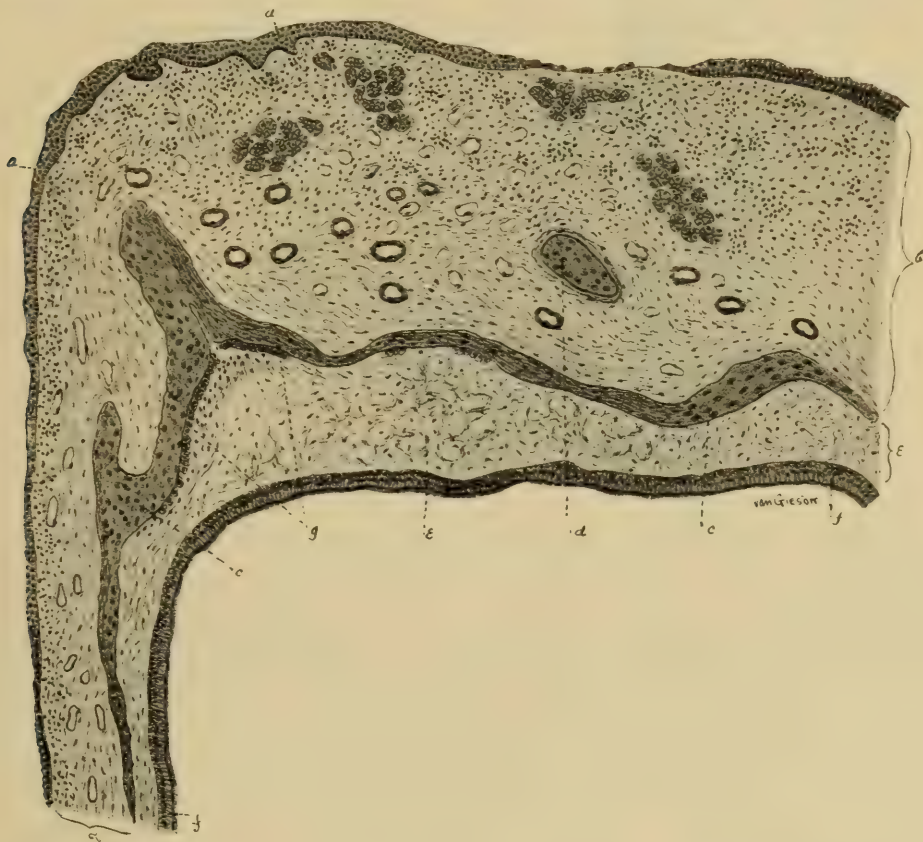


FIG. 18.—Section of Bony Cyst of Middle Turbinate. (Author's specimen.)

a, Layer of stratified epithelium; *b*, layer of richly cellular vascular connective tissue, which is rather more dense about the laminæ of bone, *c-c-d*; *e*, layer of very loosely arranged edematous connective tissue resembling myxomatous tissue; *f*, layer of ciliated epithelium; *g*, layer of osteoblasts.

the last need not be more than three or four inches from the angle to the tip. The DeVilbiss spray tubes, made of metal, are more durable, and having a movable tip will throw the spray in any direction desired. A hand ball, or one of the compressed air apparatus, according to convenience, may be used to form the spray. The pressure on the latter should not exceed twelve pounds, and often one-half that degree of force will be ample, except with the heavier oily sprays.

One of the best known solutions intended for use in this way is Dobell's solution (acid. carbolic gr. iv-x, sodæ boratis, sodæ bicarb. āā gr. xl, glycerin ℥iv, aquæ ad ℥iv). The famous Seiler tablet is quite as familiar to the laity as it is to the profession and in solution of proper strength is agreeable and satisfactory. An excellent

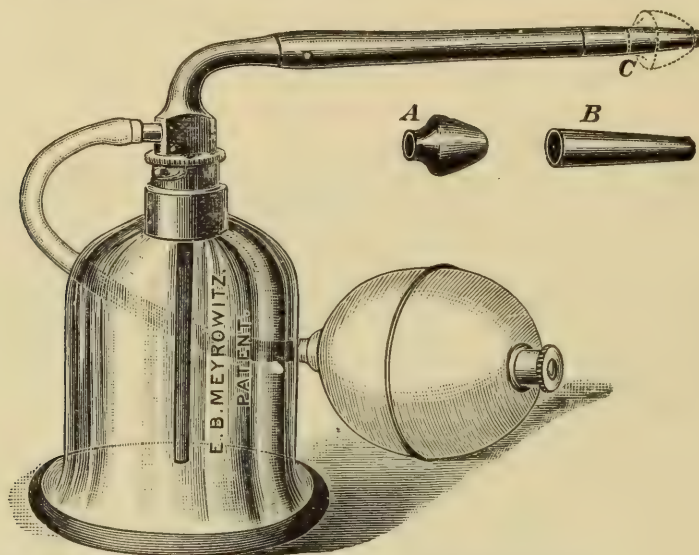


FIG. 19.—Lefferts' Hand Atomizer.

solvent for viscid secretion is warm salt water, in other words physiological or normal salt solution. In the majority of cases marked results will be obtained from menthol dissolved in fluid albolene (gr. ii-v to ℥i). Although oil and water will not mix and we cannot expect the mucous secretions and the albolene solutions to violate this law by showing an affinity for each other, yet we find

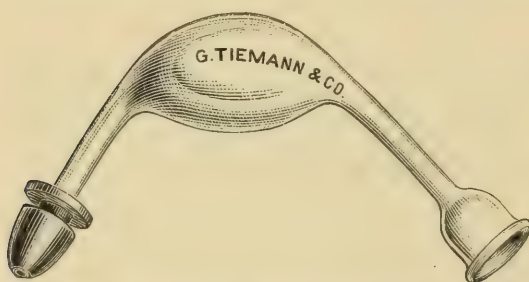


FIG. 20.—Woakes' Nasal Irrigator.

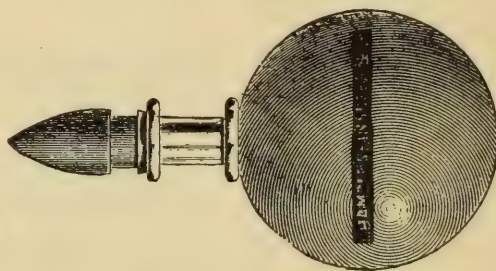


FIG. 21.—Nasal Syringe.

that oily solutions serve a threefold purpose. They ensure gradual and prolonged action of the medicament which they may hold in solution or suspension, they prevent the incrustation of secretion which is a more annoying feature of later phases of chronic rhinitis, and they furnish a protective film to the hypersensitive mucosa. It is true

that sprays alone will not cure catarrhal conditions; it is true that oily solutions are disagreeable to some patients and act unfavorably upon some mucous membranes; but the fact remains that the spray, properly used, is a valuable and an elegant agent for cleansing and medicating the upper air-passages, the larynx, and pharynx, as well as the nasal cavities. It hardly need be said that medicated applications should be preceded by thorough cleansing of the surfaces especially in atrophic rhinitis when the nares are stuffed with hard and dry secretions. One of the best detergent solutions in common use is warm salt water, one teaspoonful of table salt to a pint. It is important to observe this proportion and all lotions to be

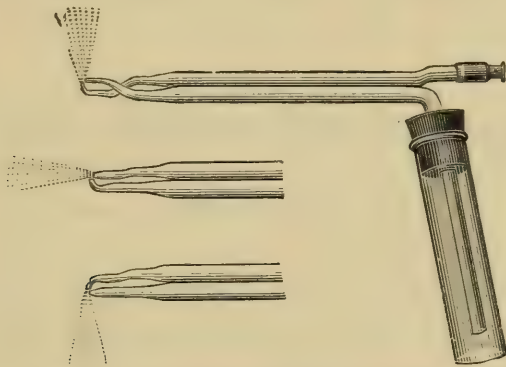


FIG. 22.—Sass' Glass Spray Tubes.

used in volume from a cup, douche, or syringe are more agreeable and more effective if applied warm. Heating the spray mixture is less important since the temperature of atomized fluids falls almost instantly, but in cold weather the oils and heavy solutions may be sprayed more readily if previously warmed. Astringents to control hypersecretion seem to be indicated, yet we find that drugs of this class are sometimes worse than useless, since the Schneiderian membrane often exhibits more or less intolerance of their action. The discomfort of the patient is sometimes increased, their effect in checking secretion is very transient, and the sense of smell is in danger of being impaired by too vigorous and too frequent applications. The use of powders of various kinds has been popular at times, but they offer no advantage over drugs already in solution and are decidedly irritating unless great care is taken in their preparation. The least objectionable is a powder of stearate of zinc with boric acid which combines mild astringent with sedative and antiseptic properties and in certain cases seems to act favorably.

Stearate of zinc is an excellent vehicle for other powders, such as aristol, euophen and iodol. It seems irrational, however, to ask the secretion of an inflamed mucous membrane to act as a solvent for these drugs, when the solution may be made more rapidly and accurately before their introduction to the nasal chambers. The value of the so-called antiseptics is, to say the least, doubtful. A solution strong enough to kill pathogenic germs must at the same time destroy the tissues.

The treatment of rhinitis at this period, therefore, consists mainly in the correction of bad habits, the regulation of diet, and the restriction of local measures to the use of remedies which tend to reduce congestion and to restore the normal function of the secretory glands.

When the chronic catarrhal process has advanced to the second stage we are confronted by a totally different condition. Here certain structural changes have taken place in the mucosa which lead to permanent narrowing of the nasal passages and which can be relieved only by surgical intervention. The method to be selected depends largely upon the particular region affected. If nasal respiration is seriously interfered with, if nasal drainage is impeded, if neuralgia or other reflex phenomena can be traced to a point of contact or pressure within the nasal fossæ, or if the sense of smell is impaired by an obstructive overgrowth, the indications for surgical interference are sufficiently clear. We rarely, if ever, meet with a lesion of this kind involving only the sense of smell. We may have reflex disorders or imperfect drainage, due to pressure, without respiratory stenosis. A lesion which prevents breathing through the nose cannot exist without interfering with drainage and generally weakens the sense of smell and provokes more or less reflex disturbance. Other considerations which should influence our choice of a mode of operating are the age of the patient, the duration of his difficulty and the temperament of the individual. In general the older and denser the hyperplasia the more energetic should be our attack upon it, but in children and in nervous subjects we may be forced to reject formidable apparatus and active agents for more tedious and less disturbing methods. Moreover, we must take care to avoid a violence in dealing with the middle turbinate body and the roof of the nasal chamber which may be exercised with impunity in the case of the inferior turbinate and the floor of the nose. If our

patient is known to be a bleeder or if there is a reason for wishing to avoid even moderate depletion, one of the bloodless methods of operating is preferable.

Hyperplastic tissue must be looked upon as a foreign body. There is no possibility of wholly restoring a mucous membrane thus affected. Until, therefore, the overgrowth is removed or reduced by surgical measures or by the slower natural process of atrophy, we cannot reasonably expect any substantial relief of symptoms. The majority of these patients have tried the various advertised nostrums for "catarrh," or at least, have been in the habit of snuffing up salt water, before they apply for special treatment, and they may be considered fortunate if they have escaped troublesome complications, especially in the form of inflammation of the middle ear. Patients



FIG. 23.—Jarvis' Cold Wire Snare.

should be invariably cautioned against violently blowing the nose, especially with compressed nostrils, after the use of a nasal wash or douche. Excessive nose blowing which many with hypertrophic rhinitis practise is damaging to the intranasal tissues as well as to the ears. In washing out the nostrils the stream of fluid should always be thrown in by the narrower nostril, so that the return current may find unobstructed exit by the other nostril.

There are three satisfactory ways of disposing of hyperplasia of the soft tissues of the nares: (*a*) By cutting operations with the cold wire snare, scissors, or forceps, (*b*) the electric cautery, and (*c*) chemical caustics.

The cold wire snare is best adapted to extreme cases in which the soft tissues protrude into the nasal passage to such a degree as to allow the wire loop to be well embedded (Fig. 23). If the surface of the hypertrophy is smooth and shades off into the adjacent parts it is very difficult to include the desired amount of tissue within the loop. To obviate this objection, Jarvis advises preliminary transfixion of the mass to be snared, the loop being then adjusted over the ends of the transfixion needle. Practically we find that this leads to cutting out a furrow along the track of the needle, if a single needle be used, and if several needles are applied the operation

becomes unnecessarily complicated. It is a good rule, therefore, to use the electric cautery for those cases in which the loop cannot be employed without the aid of transfixion needles. An ingenious suggestion is made by J. E. Boylan, who advocates ablation

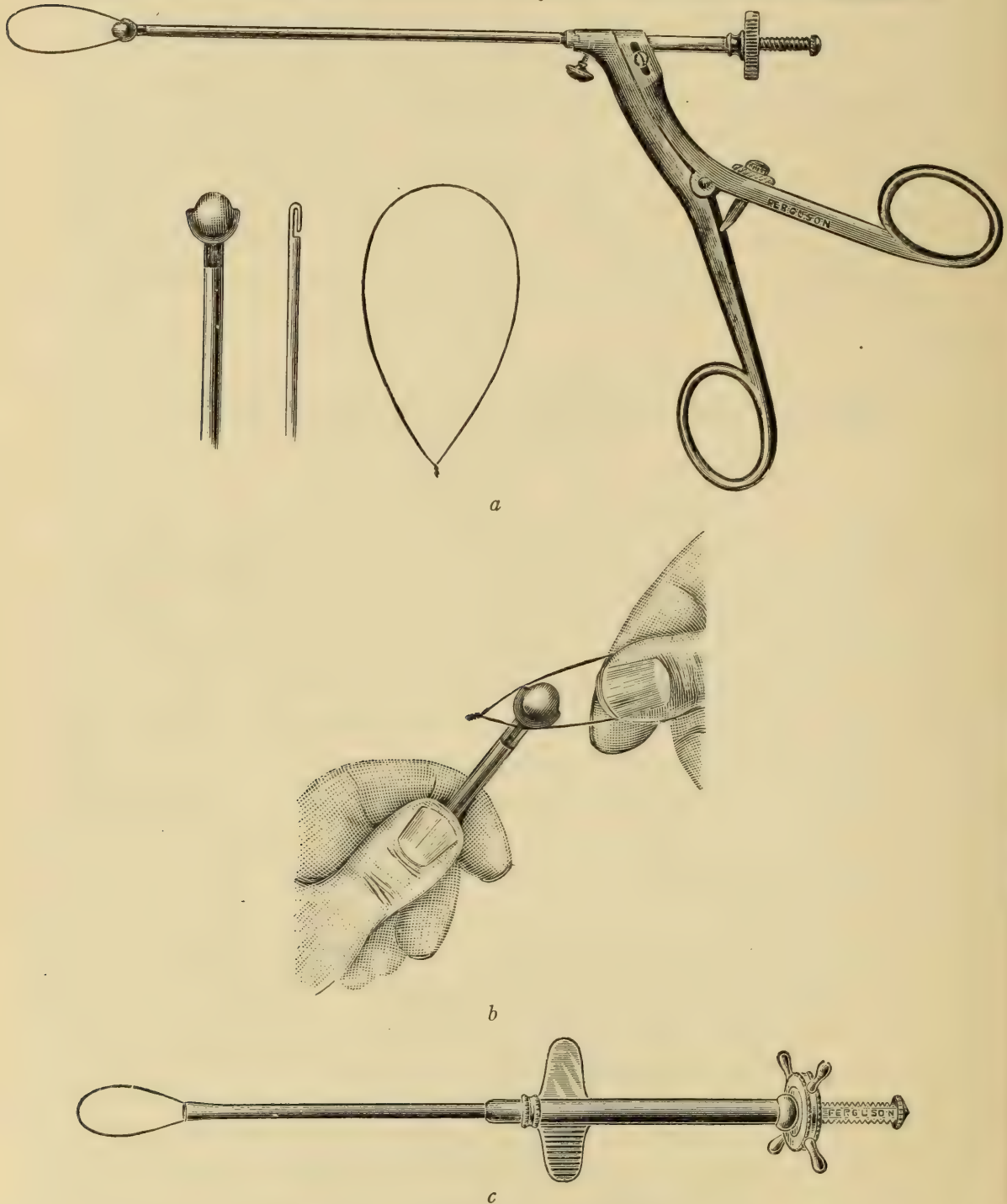


FIG. 24.—Sajous' Nasal Snare.

With Adjustable Wire Loop. *a*, This cut shows the exact size of the tip, stilette and loop. *b*, This cut shows the manner of introducing the wire loop. *c*, Sajous' Snare as modified by Dr. S. MacCuen Smith.

in preference to cauterization. The point of a fine tenaculum bent at a little more than a right angle is buried in the turbinate body posteriorly where we desire the wire to cut and and thus the amount of tissue included may be accurately determined by passing the loop over the hook. In order to prevent slipping anteriorly a shallow incision is made in the base of the turbinate and in it the wire is inserted. The hot wire loop for these minor operations within the nares is not to be recommended. With it there is danger of damaging adjacent parts which we wish to preserve. It should be reserved for those in whom we have reason to fear hemorrhage. For ordinary use Sajous' modification of Jarvis' snare is a most convenient instrument (Fig. 24). In tumors

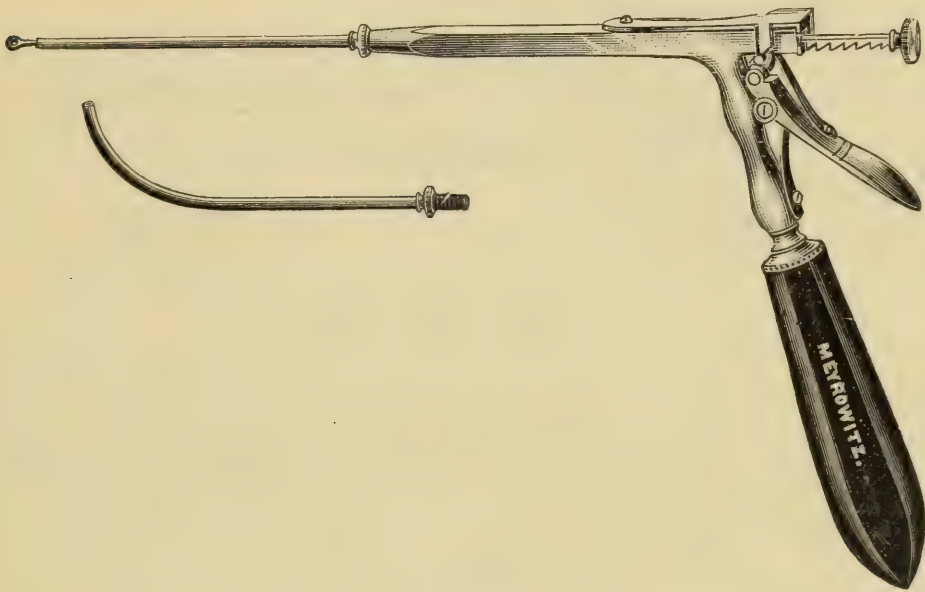


FIG. 25.—Wright's Snare.

of unusual dimensions it will be necessary to use the original Jarvis snare, which permits unlimited expansion of the loop; one end of the wire being fixed, the other end may be played out to any extent desired. The Sajous snare, however, will carry a loop only so large as its screw thread will exhaust. The great advantages of the latter are the ease with which it is prepared for use and with which the loop may be turned and manipulated, especially in a narrow nostril, from the fact that the ends of the wire are fixed at the distal end of the instrument. For polyps, neoplasms of medium size, and hypertrophies the Sajous snare meets every requirement. The cold wire snare will cut through not only the soft parts, but the bone itself, and

is especially adapted to vascular "mulberry" hypertrophies of the posterior end of the inferior turbinate and to enlargement of the middle turbinate in which it is necessary to remove the anterior end of the bone (Fig. 25). In using the snare it is well to introduce as large a loop as the nostril will accommodate. If the patient is willing to endure the pain the loop may be adjusted before the use of cocaine, the inclusion of more tissue being thus assured. There is no danger of getting too much tissue, as is true with some of the forceps devised for removing the turbinate bodies. The difficulty is to remove enough to relieve the stenosis, and for that reason it may be desirable in some cases, for example, those in which the turbinate bone must

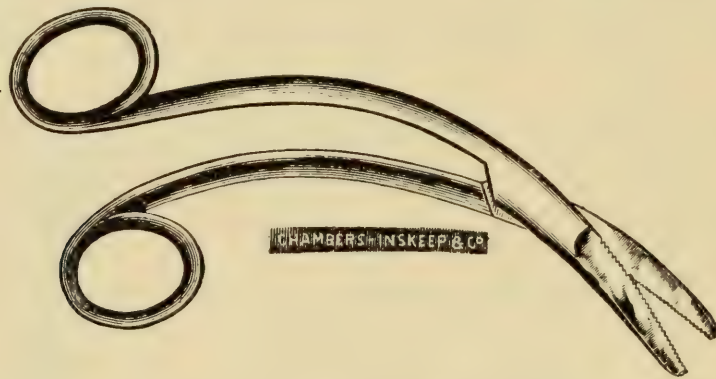


FIG. 26.—Casselberry's Nasal Scissors.

be sacrificed, to use serrated scissors like those proposed by Casselberry (Fig. 26), or the author's cutting forceps (Fig. 27). In order to prevent hemorrhage the loop of the snare should be tightened very gradually. In vascular posterior hypertrophies, which are apt to bleed profusely, a half hour or more may be consumed in making the section. On the other hand, some patients prefer to have the snaring done quickly at the cost of a little more pain and loss of blood. By following the latter course we are informed at once of the amount of bleeding, whereas otherwise, we may send our patient away with a feeling of security only to be summoned later to check a violent secondary hemorrhage. Since the introduction of cocaine episodes of this kind have been more frequent, probably owing both to reaction from the temporary hemostatic effect of the drug and to the more rapid work which the local anesthesia permits.

The electric cautery judiciously used, is one of the most valuable agents at our command. It has gained a measure of disrepute as a result of misuse. Unsuitable cases have been submitted to it, an

improper degree of heat has been employed, imperfect batteries and apparatus have been the source of great annoyance. As a result instances of violent inflammatory reaction, extending even to the meninges, have been reported, violent hemorrhage has followed the withdrawal of an excessively hot electrode, and batteries often failed to work at critical moments. At the first sitting only a very

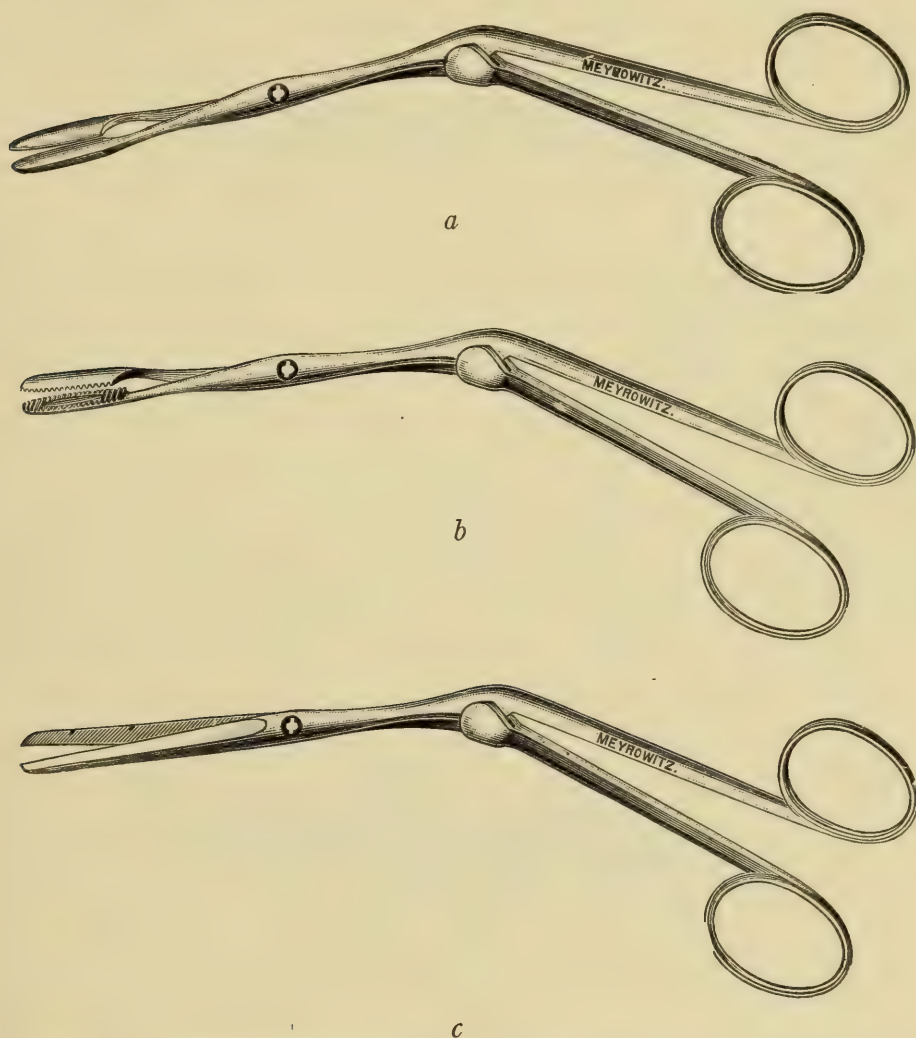


FIG. 27.—Author's Cutting Forceps, *a*; Dressing Forceps, *b*, and Scissors, *c*.

moderate amount of burning should be done and the utmost care must be taken to exclude possible contraindications. An incipient febrile state or a condition of systemic depression may be sufficient reason for postponing a cauterization, which is by no means always the trifling operation some profess to believe. A convenient source of current for surgical use is the storage battery, of which there are several varieties in the market. Being portable it may be used at

the bedside as well as in the consulting room. It has the disadvantage of requiring frequent recharging according to the amount of work demanded of it. Several efficient controllers have been designed for the street current and are more satisfactory for office use. The selection of electrodes, handles and conducting cords is important. These articles are generally unnecessarily heavy and clumsy. In using electricity we should remember that the result is accom-



FIG. 28.—Schech's Handle for Cautery Points.

plished by the heat and not by the application of force, hence, cumbersome apparatus is superfluous. The electrodes should be delicate, the handles light, and the cords not too thick and stiff. Attention to these details adds greatly to our comfort and satisfaction in using electricity. An excellent set of electrodes for the nose, larynx and pharynx with handles of ebony and bone, is known as Schech's (Figs. 28 and 29). The Kuttner handle made of metal and vulcanite is very serviceable, but is heavier. The degree of heat advised by most operators is "a cherry heat." Less heat fails to destroy to a

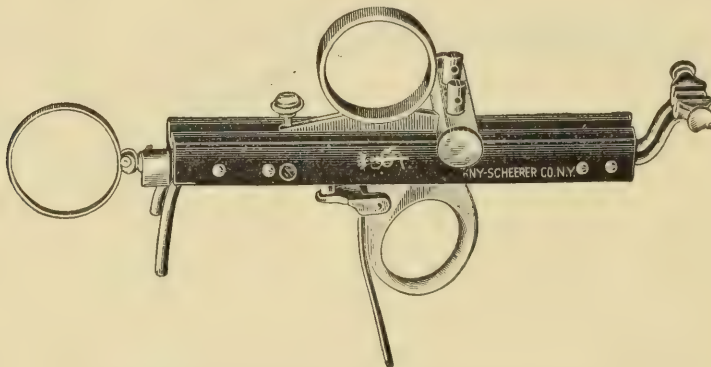


FIG. 29.—Schech's Handle for Cautery Loop.

sufficient depth and is more painful while much more than cherry heat is sure to cause bleeding. With cocaine the question of pain does not arise, and if, as is to be preferred, the electrode is applied cold to the surface to be burned the degree of heat must be just on the border line between cherry and white. Cocaine is of great service not only as an anesthetic, but in clearly defining areas of hyperplasia to be destroyed from other regions which are to be

avoided by the electrode. The nostril to be operated upon having been thoroughly cleansed with an alkaline wash, cocaine in 10 per cent. solution is applied on pledgets of cotton, the head of the patient in the meantime being bent forward to obviate the passage of the solution backward into the pharynx. In operating far back in the naris the avoidance of this accident is impossible, and the patient should be forewarned of the unpleasant consequences. Unless the nostril is excessively narrow, a septal shield, or a special speculum for protecting the septum is not necessary. The cold platinum point being pressed firmly into the tissues the current is turned on for only a few seconds and no damage is done except at the line of contact. The electrode should be gently withdrawn before it has quite cooled. Otherwise, it adheres and its detachment causes bleeding. A little experience and care are needed to carry out this step of the manipulation successfully. We thus burn through the whole thickness of mucous membrane with two objects in view, first, to destroy redundant tissues and, second, to promote absorption by the resulting cicatricial contraction. Unless this secondary effect is kept in mind more burning than necessary may be done. On the other hand, timid and superficial burning often does more harm than good by aggravating the irritable membrane. The cauterization should be thorough, but over a limited area. At the end of a week or ten days this process of *linear* cauterization may be repeated if it seems to be required. The use of a sharp-pointed electrode to be passed into the submucous tissues before the current is turned on has been proposed with a view of preserving as far as possible the surface of the membrane. The effects of the cautery in destroying the epithelium and in obliterating the canaliculi in the basement membrane, with subsequent formation of new connective tissue, dilatation of the gland ducts and more or less recurrence of nasal obstruction have been demonstrated by Goodale and others. So serious do these objections appear to some that *punctate* rather than *linear* cauterization is advocated with a view of interrupting the tissue destruction (B. Douglas). By others the cautery is discarded and various substitutes are proposed. D. A. Kuyk makes an incision through the mucous membrane to the turbinate bone, which is then deeply furrowed with a broad saw. Into this furrow the edges of the incised membrane are tucked and held with a tampon of cotton soaked in equal parts of compound tincture of benzoin and

collodion. Removal of redundant tissue and primary union of the wound are the principles involved in an elaborate operation devised by Yankauer. The soft parts having been cut away by incisions above and below the redundant portion, enough of the bone is removed with punch forceps to permit the lips of the wound to be brought together with catgut sutures. A number of special instruments are needed in order to enable one to carry out the technical details with satisfaction. The advantages are abbreviation of the process of repair and decrease in risk of local sepsis. As a matter of fact, in most cases the whole thickness of the mucosa is involved in the morbid process, it cannot be supposed that a dense hyperplastic turbinate is capable of performing its normal function, and there is no object in attempting to save the surface. The foregoing observation applies with equal force to sub-mucous injection of acids or other solutions intended to shrink the tissues and to various ingenious plastic operations upon the turbinate bodies which have a similar end in view. Interest in these conservative methods seems to have been recently revived and we find sub-mucous injections of zinc chlorid in ten per cent. solution advised by Gaudier, who however admits that results are uncertain and that cauterization or resection of the turbinate must be resorted to in many cases. The experience of Hamm, Viollet and many others authorizes the conclusion that a dense hyperplasia cannot be satisfactorily reduced in this way. The interstitial application of chromic acid is facilitated by the use of Goldstein's "turbinal trocar." The trocar and canula, the latter provided with an adjustable ring for regulating the depth of insertion, are plunged into the hypertrophied tissues and after withdrawal of the trocar a probe armed with chromic acid is passed through the canula and drawn out together with it. Thus a line of caustic is deposited along the track of the instrument. Although these methods may be simple of execution, painless under cocaine, free from violent reaction and from the danger of adhesions, we fail to see their advantages or efficacy in genuine hyperplasia, while in simple hypertrophy milder methods will generally suffice. In certain cases of nasal obstruction due to chronic turgescence of the turbinates from vasomotor derangement Delavan proposes to effect retraction of the swollen tissues by submucous incisions, thus dividing and ultimately obliterating the venous sinuses. A very fine lance-pointed knife or needle is used and punctures are made at

different points according to the extent of swelling. The results of this method are said to be permanent.

Nearly all the chemical caustics, from strong nitric acid down, have been tried in hyperplastic rhinitis. They share the objection that, unless extreme care be exercised in applying them, they are apt to spread and burn over too wide an area. At the present time chromic and trichloroacetic have supplanted other acids. There seems to be no decided choice between them, except on the ground that toxemia may result from the former in case it is applied too freely, or of individual idiosyncrasy. Chromic acid is kept in crystalline form and at the moment of using a few crystals are fused on the end of a probe. A copper wire, five or six inches long, flattened at its end for half an inch, makes a good applicator. The acid is deliquesced by the addition of water and the flat end of the probe is dipped in the solution. One side of the probe being wiped dry with a bit of absorbent cotton the other side remains charged. Thus armed the copper probe can do no harm to the septum, for instance, when we wish to burn only the turbinate body. The action of the acid is very prompt. It soon exhausts itself upon the tissues and there is no need to neutralize it unless an excessive quantity has been accidentally used. Within a week the eschar thus produced separates or comes away in fragments and another application of the acid at the same spot is usually required. There is seldom any complaint of pain or reaction, except in neurotic subjects, or in case the application may have been extravagant. Some patients object to the disagreeable odor of chromic acid. In such the trichloroacetic acid is preferred. Its energy of action is almost, if not quite, equal to that of chromic acid. It is pleasanter to handle and is free from toxic qualities. It is used with a Gleitsmann applicator, or may be applied by means of a fine nasal probe wound with a thin film of absorbent cotton.

While the active treatment is being carried out local cleanliness and asepsis must be maintained by the use of sprays and irritating conditions of all kinds must be remedied as far as possible. The patient should be seen every two or three days and the formation of adhesions guarded against by the passage of a probe until healing and retraction have well progressed.

A form of nasal obstruction in which the inferior meatus is almost completely obliterated by thickening of all the tissues composing the

inferior turbinate body is quite common. The current of air in respiration passes by the middle meatus while the floor of the nose is occupied by the swollen turbinate bathed in detained secretion. The drainage and ventilation of the nasal chamber are manifestly defective, and although the patient may respire through the nose by day he becomes a mouth-breather at night, the posterior nares and

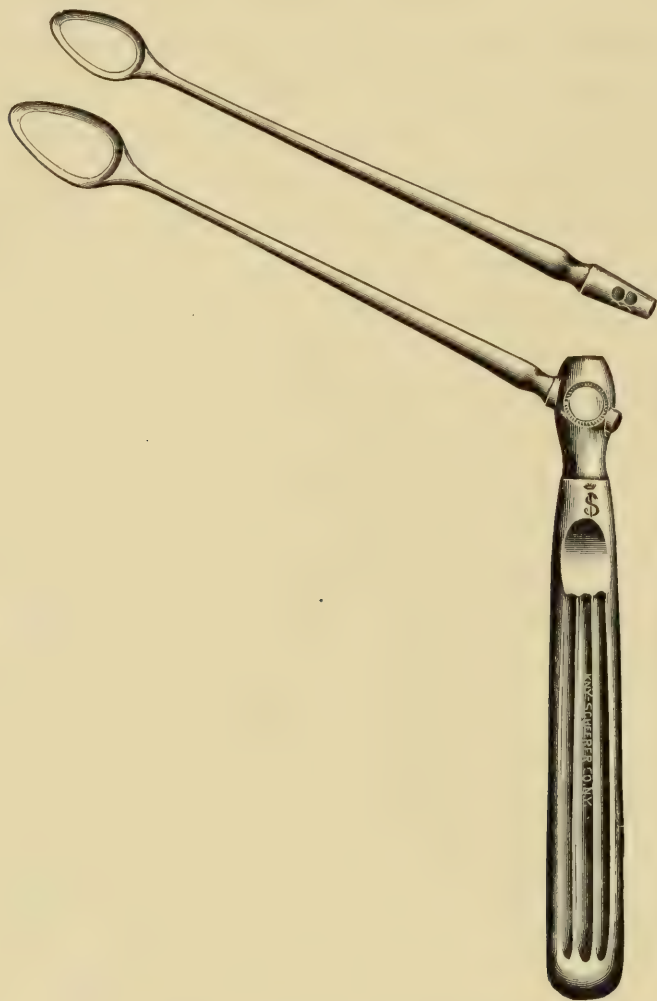


FIG. 30.—Berens' Spoke Shave.

pharynx giving evidence of the latter. In order to remedy this condition the bone itself must be removed. This may be done with a pair of strong nasal scissors. The anterior end of the bone is usually most at fault and especially in a narrow nostril it is necessary to apply the blades of the scissors well down at the base of the turbinate. In extreme cases the saw or the cold snare works well, or one of the various conchotomes (Fig. 30) may be preferred. The so-called

nasal plane, or spoke shave, has justly lost its popularity. It is apt to carry away too much tissue and many cases of alarming hemorrhage after its use have been reported. The objects in view are to restore the normal patency of the nostril and leave a smooth symmetrical stump. With strong solutions of cocaine (10 to 20 per cent.) and adrenal extract, this operation of turbinectomy, which should never be a complete resection of the bone, may be done painlessly and bloodlessly. Attempts at twisting off a turbinate body or avulsion with forceps are not to be recommended. The entire bone might be dislocated by immoderate violence. Plugging the nostril except for hemorrhage does not seem desirable, although Lake's india-rubber splint, or similar dressings of celluloid are used by many. In the opinion of Pegler the rubber splint, which is aseptic and easily removed and kept clean, saves the necessity of subsequent trimming in consequence of the gentle uniform pressure it exerts upon the roughness inevitably left by the operation. Simpson's tampons of Bernays' compressed cotton, especially when covered with rubber tissue, collodion, or a thin sheet of vulcanite as suggested by Chappell, are sometimes useful in suppressing excessive granulation, but they must not be left in too long, and care should be taken not to use too thick a tampon lest in expanding it cause intolerable pressure. It is the belief of the author that most of these cases do better without such a foreign body in the nose even though it may not be very irritating. The case should be carefully watched during convalescence and exuberant granulations should be reduced with the knife or a light touch with the electric cautery.

The use of hot air, first suggested by Vansant for the relief of headache, has been recommended in various morbid conditions of the nasal membranes by Lermoyez and Mahu and more recently by Lichtwitz. The current of air, at a temperature of 70° to 90° C., is propelled against the affected surface by a special mechanical device, consisting of an electromotor pump and an arrangement for warming the air, and is said to exercise a beneficial effect not only in simple engorgement of the erectile tissue but also to some extent in hyperplastic conditions. It is possible to conceive that the nutrition of an affected area may be so changed by continuous or oft-repeated applications of heat as to arrest a diseased process or possibly to promote absorption of inflammatory products, but a dense organized hyperplasia would certainly not seem to offer a highly encouraging

field for experiment with such a method. It is believed that more rapid and radical procedures will give more satisfaction.

The question is often asked whether the results of treatment or operation are permanent. In the majority of cases it is safe to answer in the affirmative provided the causes which instituted the catarrhal process can be discovered and eliminated. So many elements are concerned in many cases, as regards both the individual and his environment, that it is not always possible to ensure this provision. But should signs of nasal insufficiency recur after a longer or shorter interval owing to reëstablishment of hyperplasia that fact would be no reason for abstaining from treatment. It is a simple matter to repeat a cauterization if necessary, and the principle should be constantly kept in view that wholesale destruction of intranasal tissue is not the chief end of rhinology. Attempts to restore the function of crippled structures are far more commendable than substitution of cicatrices for erectile tissue even though the latter be impaired. In many cases digestive or systemic derangements are of first importance, and endonasal surgery should be looked upon as a last resort.

CHAPTER III.

ATROPHIC RHINITIS. MEMBRANOUS RHINITIS. CASEOUS RHINITIS. PURULENT RHINITIS.

Atrophy is a sequel of inflammation rather than itself an inflammatory process. Various theories have been proposed to account for it. The majority of cases result from antecedent hyperplasia, the atrophic change in the nasal membrane being due to lessened blood supply from interstitial pressure which obliterates the vessels and at the same time interferes with innervation and glandular function. Some authorities believe in a *primary* atrophy and, in a certain proportion of cases, it is impossible to find evidence of preëxisting hypertrophy. A third theory, of which Bosworth is the principal champion, refers the atrophy to a purulent rhinitis as met with in children. Other observers, notably Cholewa and Cordes, maintain that the process begins in the bone, thence invading the mucous membrane. The argument in favor of this view is extremely plausible. Progressive bone absorption, due to causes not yet explained, obliterates the radical arteries and veins lying side by side in the bony canals, whence a portion at least of the blood supply of the soft parts is derived. In consequence the nutrition of the mucous membrane suffers and atrophy ensues. The causes which institute these alleged primary bone changes are not disclosed, but the admission of their existence in a measure explains the inefficacy of treatment in many cases of atrophy. Some authorities regard it as of neurotic origin, a trophoneurosis, and still others as consequent upon disease of the accessory sinuses (Grünwald). The sinus or "focal" theory is weakened by the frequent occurrence of atrophy without involvement of a sinus, as well as by its practical cure while a sinusitis still persists. On the other hand a sinusitis may be cured with no change in a coincident atrophy. The constitutional dyscrasia generally present is considered by some a result, by others a cause, of the nasal lesion. Congenital deformities of the nasal fossæ, especially a short antero-posterior diameter (platyrrhiny), are looked upon as favoring an atrophic process. The discovery of

certain bacteria in the secretions of an atrophic rhinitis has led to the adoption of a bacillary theory. Finally, a recent hypothesis is based on the observation that a metamorphosis of columnar into squamous epithelium, or an "epithelial metaplasia," may exist from infancy or birth. This condition is thought to be an etiological factor, especially in the presence of marked disproportion between the vertical and lateral diameters of the skull giving abnormal width to the nasal fossæ. Malformations, particularly imperfectly developed turbinate bones, and spurs and deviations of the septum are undoubtedly predisposing causes. Atrophy is apt to follow also various exanthematous diseases. It is usually met with rather early in life, a fact which has given prominence to the idea that purulent rhinitis is a predisposing cause. The influence of micro-organisms is by no means determined; their presence cannot be denied, but it is probably nothing more than a coincidence. On the other hand, it is the opinion of Lermoyez that the active causative agent is the so-called bacillus of Perez, which is said to be capable of developing the characteristic ozena and of creating the disease by animal inoculation. These facts being admitted, a belief in its contagiousness follows and measures to prevent transmission are demanded.

It is clear that no single theory explains every case and that in some several of the causes, or conditions, mentioned are concerned. From a clinical standpoint the evidence that hyperplasia tends to promote atrophy is conclusive, a view sustained by microscopic testimony.

In the early stages of many cases of so-called atrophic rhinitis the pathological changes are limited to the mucous membrane and constitute a true fibrosis. Eventually bone involvement may occur. The latter is thought by some to be especially frequent in tubercular and syphilitic subjects. The changes in the membrane consist in the usual connective tissue overgrowth following chronic inflammatory processes which result in contraction. This so-called sub-mucous cicatricial contraction involves the blood-vessels as well as the glandular elements, the degree of functional disturbance and the prognosis depending upon its extent.

The *diagnosis* of atrophic rhinitis may sometimes be made from the fetid odor alone. On inspection of a nasal fossa affected by atrophy the passages are found more or less clogged with masses of

inspissated secretion the removal of which exposes the membrane, pale in color and obviously thinned. The shrinkage may be universal or limited to certain areas and, on palpation with a probe, it is a simple matter to demonstrate the extent of the atrophied surface. In extreme cases, it is possible on anterior rhinoscopy to see the posterior pharyngeal wall and the action of the palatal muscles is plainly visible while the patient pronounces a nasal consonant. It is necessary to distinguish genuine atrophic rhinitis from two other conditions which resemble it in some respects. More or less confusion has prevailed and difference of opinion as to prognosis and treatment has arisen from a failure to differentiate these various conditions. In the first place we should recognize the occasional existence of a *vascular collapse* of the nasal erectile tissue accompanied by dryness of the mucous membrane. This is much more common in anemic persons and in the female sex. There is no characteristic physiognomy such as we see in advanced atrophy. The mucous membrane is pale and retracted on the subjacent bone. The condition usually involved both nostrils. There may be no impairment of the sense of smell. There is no odor perceptible and the secretions are scanty. The condition may disappear under improvement in the general health and requires no attention locally. Secondly, there is a form of rhinitis with diminished mucous secretion, called *rhinitis sicca* which is observed in adults, usually of the male sex, in those of full habit and a gouty tendency. The mucous membrane, instead of being pale, is congested. The turbinate bodies may be turgescient. There may be erosions, especially of the septum, possibly accompanied by perforation. Frequently the condition is unilateral, but it is generally seen on both sides. It is not readily curable by local measures alone, but improves under the use of antilithic remedies.

The *symptoms* of atrophic rhinitis relate chiefly to disturbances caused by altered secretion. The mucus loses its fluid, serous character, tends to become rapidly inspissated, and form characteristic crusts or scabs which attach themselves firmly to the mucous membrane and are very difficult to remove. Their extraordinary adhesiveness is regarded by some as an etiological factor, the vitality of the subjacent tissues being impaired by the compression they exert. The retention of these crusts is due not only to their character but to the fact that abnormal widening of the nasal pas-

sages prevents the blast of expired air from exerting its usual force. The disappearance of cilia from the epithelium, a constant phenomenon in atrophy, is no doubt an important factor in derangement of secretion. True ulceration of the mucous membrane is rare, but, when it exists, is a result of the habit of picking the nose to dislodge accumulated secretion. Nosebleed may result from violent attempts to clean the passages by blowing. The patient has a constant feeling of stuffiness and desire to blow the nose even when the accumulated material is not excessive. One of the most distressing symptoms in bad cases is the fetid odor, or *ozena*, a term which is mistakenly applied by some to the disease itself. It should be reserved for the *symptom* of the disease since *ozena* is met with not only in atrophic rhinitis but in syphilis, malignant disease, and in obstruction from a foreign body or from deformity or disease of the nasal fossæ. It is much more pronounced in some cases than in others. If the patient himself has lost the sense of smell it may not be perceptible to him. Fetor seems to be quite independent of the quality and the quantity of secretion, frequently being very marked when the latter is scanty. According to Freese, it is due to acid decomposition of the fatty and albuminous constituents of the secretions. No doubt in some cases the fetor may be traced to secretions retained in an accessory sinus, but pronounced *ozena* is not unusual when these adjacent cavities are above suspicion. In certain individuals there seems to be some inherent quality in the tissues or secretions whence emanates a peculiar odor analogous to that sometimes observed from the sweat glands. There is seldom any pain although the patient may complain of a dull, heavy sensation over the bridge of the nose and in the frontal region. On the other hand severe headache especially in the forehead may occur. Many patients show rather sluggish mental operations and are very apt to be depressed in spirits. Not infrequently secondary disturbances of the pharynx and larynx occur and gastric derangements are often met with and, sooner or later, distinct impairment of the general health is noticed. The latter fact, in conjunction with an obstinate cough often present, is likely to excite apprehension of lung disease. In well-marked cases a peculiar facial expression, shown in the widely expanded nostrils, snub-nose, the dull countenance and thick lips, is thought to be characteristic.

The *treatment* of atrophic rhinitis has in view two objects: the

correction of the fetid odor and the restoration of glandular function. The former is always feasible, the latter is not when the process of degeneration has advanced to an extreme degree. The fact that the disease, if not caused by a constitutional diathesis is certainly aggravated by a depressed state of the general health suggests the necessity of combining local with general treatment. The use of tonics, attention to hygiene and the correction of digestive derangements are of the greatest importance.

The internal use of mucin, especially with a view to its influence upon secondary derangements of the digestive tract, has recently been urged. It is given in tablets containing five grains each of mucin and bicarbonate of soda. A watery solution is used as a douche to the nose and pharynx. It is said to counteract the dryness of the membranes and to relieve the gastrointestinal disorders which are a frequent consequence of deficiency of normal mucous secretion



FIG. 31.—Lefferts' Postnasal Syringe.

due to atrophy (Stuart Low). The antagonism supposed to exist between the flora of the nose and of the mouth suggests the use of the saliva as an intranasal germicide. The unique proposal is made by Iglauer to establish an oronasal fistula through which the patient may at will give his turbinate bodies a salivary bath.

In approaching the question of local treatment we are amazed at the large number of drugs which have been resorted to at various times. The inference is that in general experience the disease has been found rebellious to treatment. So true is this that many practitioners conclude that cleanliness is all that can be accomplished by any course of treatment whatever. While this may apply to the worst cases of atrophic rhinitis, nevertheless if the process be identified at its inception much may be done. There is no question that thorough cleansing of the surface is important before medication should be attempted. The removal of the dried secretion is often a very difficult process and cannot be effected by the patient himself, at least, at the outset of treatment. Simple douching of the nose or

spraying is only a partial mode of accomplishing the end and must be supplemented by systematic brushing of the surface of the mucous membrane with sterilized cotton wound on the end of a nasal probe. It is a good plan first to soften the secretions thoroughly by means of a coarse spray or douche of normal salt solution as hot as the patient can comfortably bear. In some cases when the crusts invade the nasal pharynx it is necessary to cleanse from behind forward by means of a postnasal syringe (Fig. 31) or Holmes' postnasal douche (Fig. 32). Having removed all the secretions we are prepared for the application of an agent which will stimulate glandular action

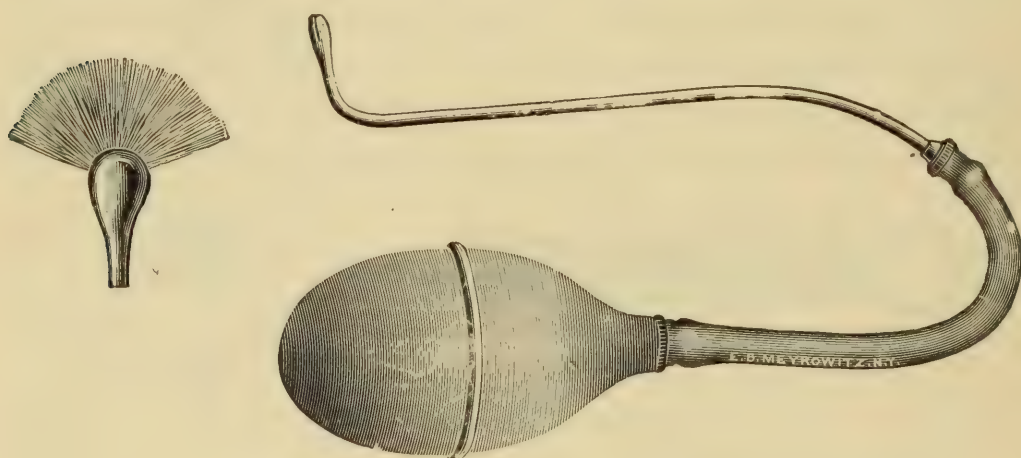


FIG. 32.—Holmes' Post-nasal Douche.

provided the glands have not been entirely destroyed. One of the best applications for the purpose in most cases is a solution of menthol in albolene in the proportion of ten grains and upward to the ounce. This may be applied twice a day after the use of the salt water. An excellent stimulating application is a solution of formaldehyde, an agreeable preparation of which is borolyptol which contains 1 to 500 of formaldehyde. This must be still further diluted since it is very irritating, but it has the double advantage of stimulating the mucous membrane and acting as a powerful deodorant. Citric acid in powder with an equal quantity of sugar of milk has been observed to control the fetor and crust formation. Nitrate of silver, in solution of twenty to sixty grains to the ounce, or even stronger, has been widely used but seems to offer no advantage over other preparations less disagreeable to handle. Some of the modern compounds of silver, protargol and argyrol, may be destined to find a permanent place in therapeutics. Hydro-

gen dioxide finds favor with many practioners, who accept the bacterial theory of origin. Even if germs are concerned, attempts to render the nasal chambers absolutely sterile are of doubtful expediency. Solutions strong enough to accomplish the object must endanger the vitality of the tissues. It remains to be seen whether injections of the lactic acid bacillus are of service. Theoretically they should be, and quite encouraging reports have been made by North, Curtis and others, while in some of our large clinics results have been negative or worse.

An ideal antiseptic, if all that is claimed for it be true, is offered in *gomenol*, a vegetable product said to possess extraordinary germicidal power while being free from irritating properties. It is the ethereal oil of *melaleuca viridiflora*, a plant growing near Gomen in New Caledonia. A 10 to 50 per cent. solution in sterilized olive oil is an agreeable and effective application. One of the best preparations, provided its odor is not objectionable, is ichthyol, which is used in a 5 per cent. solution in kerolin or, as preferred by many, in much stronger solution, or even in a pure state over a limited area. When a deformity or stenosis interferes with nasal drainage or forms a site for the lodgment of secretion it should be removed; otherwise no intranasal operation is advisable. Superficial erosions usually undergo repair without special attention as the secretions and the membranes acquire a more healthy character. In some cases a dilated naris, due to deviation of the septum, admits an excessive volume of air which may be reduced by wearing a film of absorbent cotton in the nostril or by replacing the deflected septum. Some of these patients are persistent mouth-breathers, although the nares are sufficiently spacious. They complain that they cannot *feel the air* in breathing through the nose, a state of things due to anesthesia of the mucosa. The idea of making an artificial turbinate by means of submucous injections of paraffin has been suggested by Richard Lake. In a case of bone absorption the abnormal width of the nasal canal was counteracted by bolstering up the soft parts with five-minim injections of paraffin made at weekly intervals until a body of proper size was formed. The relief of discomfort was complete. A similar proposal has been made by Brindel, who claims to have observed disappearance of the tendency to stagnation and drying of secretion and actual restoration of normal glandular function. In extreme cases this method is impracticable owing to the difficulty

in inserting the needle between the bone and its thin covering of mucous membrane (Burger).

The effects observed from the use of dionin (ethylmorphine) in the eye led to its adoption in nasal atrophy (Stiel). It seems to have the capacity to cause swelling of the turbinates without excessive irritation. The secretions gradually become more normal and crust formation diminishes. The drug is used in the form of powder, or in 5 to 10 per cent. solution.

The application of Bier's artificial hyperemia to atrophy commends itself by its tendency to promote nutrition and stimulate functional activity. It is still under trial.

The great interest in serum therapy naturally excited the hope that something might be accomplished in that line in atrophic rhinitis. Many experiments have been made resulting in wide divergence of opinion. The discovery in the secretions of a "diphtheria-like" bacillus has led some observers to declare that atrophy is a form of chronic nasal diphtheria. Some claim to have cured advanced cases by the repeated injection of ten centimeters of Roux's diphtheria antitoxin. Others pronounce this dose excessive and allege that the treatment is dangerous although it gives positive results in the disappearance of dryness and crust formation with the relief of ozena. This is not likely to supersede safer and equally efficacious modes of treatment.

In addition to the medicinal agents already mentioned for treating atrophic rhinitis we have at command various resources more or less serviceable. Nasal bougies, medicated, or otherwise, have been used. Plugs or tampons of cotton have been recommended with the idea of partially obstructing the nasal passages for the purpose of inducing more or less congestion of the mucous membrane with increased functional activity. The method of Gottstein consists in packing the nasal fossæ with dry non-absorbent wool which is renewed at the end of twenty-four hours. Thus a tendency to crust formation is corrected, a more healthy action of the glands is established and the mucous secretion becomes more fluid. A plan for removing as well as preventing the formation of crusts is urged by Sondermann. A flexible rubber bag is passed into the naris and then dilated by means of a hand bulb. The bag adapts itself to the irregularities of the nasal fossa and when withdrawn in five or ten minutes is found to bring with it the tenacious secretions. The

process is repeated once or twice a day as may be required. Areas of eroded granular membrane underlying crusts of dried secretion are sometimes encouraged to repair by application of a sharp curette, but it should be used with caution since our efforts should be directed to the preservation and restoration of tissue. Electrical treatment of atrophic rhinitis is applied in the form of the galvano-cautery in cases similar to those in which the curette is admissible; second, by the constant or interrupted current; and, third, by electrolysis. Their effect with the exception of that first named consists in stimulation of glandular function and is good in cases not too far advanced. These methods are tedious and require frequent repetition and special apparatus. The use of galvanism gives excellent results in suitable cases, that is, those in which the glands have not been completely obliterated by the atrophic process. A flat sponge electrode connected with the positive pole of a constant current battery is applied to the nape of the neck. The negative pole, a metallic electrode, is placed in direct contact with the mucous membrane of the nose. It is rather more agreeable to the patient to use in the nose a copper wire electrode loosely wound with absorbent cotton. If both nostrils are to be treated the nasal attachment may be double, a section for each nostril, as suggested by Delavan. The strength of the current should not exceed seven milliampères and the duration of each sitting should not be more than twelve minutes. The patient feels a sensation of warmth but no pain, unless the current is too strong. A slight watery secretion is excited by the application and in course of time the quality of the nasal mucus is perceptibly improved.

Cupric electrolysis is warmly commended by some observers. Strong currents are very painful and a general anesthetic may be required. Watson Williams, who claims better results with this than with any other method of treatment, prefers mild currents at intervals of two or three weeks until increased secretion and vascularity and diminished fetor are noted. The parts having been cocaineized "a copper needle attached to the positive pole is inserted into the tissues of the inferior or middle turbinated body, and a steel needle, attached to the negative pole, into the septum, and a current of from five to ten milliampères is passed from ten to fifteen minutes." This process should be repeated until the symptoms yield and on signs of recurrence. The results of vibratory massage

are not especially encouraging and the proposal of Flatau to excite tissue proliferation and increased secretion by driving ivory pins into the turbinate bone will hardly appeal to a large number. The curative effect of erysipelas in nasal atrophy noted by several observers has led to the suggestion that injections of Coley's fluid might be useful in cases of this kind (Somers). The symptoms and consequences of atrophy seldom justify taking the risks of such treatment.

Phototherapy and radiotherapy are said to have given good results. The only objection is the occasional occurrence of headache and vertigo (Dionisio). Special apparatus is required.

Spontaneous recovery sometimes takes place, that is the symptoms cease although normal tissues may not be regenerated. In adolescents approaching puberty and in women at the menopause amelioration follows when these critical periods have been passed. Whatever course of treatment be selected in a case of atrophic rhinitis pronounced results must not be expected in weeks or even months. The secret of success lies in the early adoption of a systematic régime, which includes both local and general medication and which must be continued with persistence.

MEMBRANOUS RHINITIS.

An inflammation of the nasal mucosa characterized by the formation of a membranous or fibrinous exudate is occasionally seen in which the membrane shows no tendency to invade the pharynx and which is not attended by any indications of constitutional disturbance. The condition differs from diphtheria in being a much milder type of disease as regards local as well as general disturbance. There may be some rise of temperature and a good deal of nasal stenosis but there is no sign of sepsis and the disease is not contagious. It differs from diphtheria also in that glandular involvement is rare, the diphtheritic odor is absent and the Klebs-Loeffler bacilli seldom can be found. The membrane is easily removed and generally reforms. Similar conditions are seen after the use of strong caustics in the nose and after the galvanocautery especially in those depressed in health and ill nourished. The importance of the diphtheria bacillus in membranous inflammations is opened to question by the discovery by Meyer of large numbers of virulent bacilli in membrane formed

after the use of the galvanocautery as well as in a majority of cases of fibrinous rhinitis. In a great variety of nasal diseases examined by Vansant the mucous secretion showed the presence of the diphtheria bacillus in a large percentage. Pluder believes that fibrinous rhinitis is really a mild form of diphtheria, having found the bacillus in all of five cases examined microscopically. Either the Klebs-Loeffler bacillus is of no consequence, or else there exist "true" and "false" bacilli which even expert microscopists differentiate with difficulty. Unless the possibility of infection be conceded the condition cannot be regarded as very important and active interference is not indicated. In some cases general tonics are desirable and the comfort of the patient is increased by gentle removal of the membrane and applications of antiseptics and mild astringents in oily solution.

CASEOUS RHINITIS.

The name caseous rhinitis is given to a rare and curious form of inflammation in which the nasal passages are occupied by a material resembling cheese or putty. It is said by some to develop in strumous individuals and in connection with nasal polypi. It would seem to be a result of fatty degeneration of secretion which has been long retained either in an accessory sinus or in the upper part of the nasal fossæ. A prominent symptom is a sensation of stuffiness in the nose accompanied by headache. The sense of smell is usually lost and the fetor always present is not apparent to the patient. This state of things may be corrected by careful attention to cleanliness, the cheesy mass being thoroughly removed and the nasal cavities afterward sprayed with antiseptic solutions. At the same time the morbid condition which gives rise to the perverted secretion must be found and eradicated. In a recent case in my own clinic an intolerably offensive mass of cheesy accumulation was removed from the nose of a fairly intelligent man whose only complaint was of headache and nasal stenosis. Such a condition could result only from the grossest neglect. This disease must not be confounded with a false *rhinitis caseosa*. The latter is always dependent upon a foreign body, a rhinolith, a tumor, or a chronic sinusitis, while in the true no such cause can be found. Its dependence upon a specific microbe, the *Streptothrix alba*, as described by Guarnaccia, and its relation to

scrofula, as maintained by Cozzolino and others have recently been stoutly denied by Michele. Its rarity, the rapidity of its cure, the absence of recurrence, a single case having been reported by Massei, added to the fact that the disease is practically unilateral would seem to exclude a scrofulous origin. According to Michele no specific microbe can be found, hence if we accept this observer's views we shall still be in the dark as to the etiology of the disease.

PURULENT RHINITIS.

Purulent rhinitis is a variety of catarrhal inflammation of the mucous membrane in which pus formation is the prominent symptom. It is not intended to include in the term that form of rhinitis which occurs as a *specific* infectious disease transmitted to the newborn from the vagina of the mother. It occurs, as a rule, in infants as a result of exposure to irritants, either in the air or in the secretions of the maternal passages. The nasal discharge is very irritating and produces excoriation of the upper lip, and both nostrils are usually affected. There may be but little obstruction to nasal breathing. The secretion is more or less odorous, especially if the nostrils are not faithfully cleansed. A mucous membrane affected in this way is apt to be permanently impaired. By some observers this condition is believed to be an invariable precursor of atrophy.

The treatment consists in careful cleansing of the nasal passages by an alkaline antiseptic solution, followed by an application of mild astringents. In many cases, indications of struma or constitutional impairment demand general as well as local treatment.

A purulent nasal discharge in a child may be symptomatic of adenoids in the rhinopharynx. It may occur in syphilis or as a result of gonorrheal infection; in the former case the usual constitutional treatment is indicated, and in the latter precautions must be taken to prevent contagion and to protect the eyes.

CHAPTER IV.

DISEASES OF THE ACCESSORY SINUSES. ACUTE AND CHRONIC SINUSITIS. HYDROPS ANTRI, OR SEROUS EFFUSION AND CYST OF THE ANTRUM. FOREIGN BODIES AND NEOPLASMS.

The accessory sinuses when inflamed present certain features in common which may be considered before discussing individual cavities.

Acute sinusitis may occur in connection with a "cold in the head" either as a result of direct infection or of swelling of the nasal mucous membrane which causes a damming up of secretion. It is met with in the course of the exanthemata, of typhoid, diphtheria and erysipelas, and has been particularly observed as a complication or sequel of influenza. Acute inflammation of the sinuses may also follow traumatism and many cases are on record in which a foreign body has been driven into the frontal or maxillary sinus with the result of causing an acute empyema. The sphenoidal sinus and the ethmoid cells are less exposed to injury but similar cases have been reported in connection with these cavities. A blow on the face has been known to cause inflammation of the antrum and a case has been recorded by Rees in which empyema of the antrum in a child two weeks old resulted from compression of the head at birth. This must have been a precocious infant if, as we are told, the antrum of the new-born consists of a mere "indentation" on the outer wall of the nasal fossa. A tendency to spontaneous cure of an acute process undoubtedly prevails in the absence of any lesion or anatomical peculiarity which may act as an obstacle to evacuation of the products of inflammation.

A symptom invariably present in acute sinusitis is pain, as a rule referred to the region of the affected cavity and accompanied in the case of the frontal and the maxillary sinus by sensitiveness on external pressure, and by swelling and possibly edema of the overlying soft parts.

A *chronic* sinusitis may follow an acute attack, or may be characterized by absence of acute symptoms from the outset. The pain

associated with chronic sinusitis is seldom intense and its situation is often of but little diagnostic value. For example, supra-orbital pain may be a symptom of antral rather than frontal sinus disease. In ethmoidal disease the pain is usually referred to the bridge of the nose, while in sphenoidal disease the back of the head is chiefly affected. A unilateral discharge of pus in the adult is always suggestive of sinus disease although bilateral sinusitis is by no means uncommon, having been found by Wertheim in 38.7 per cent. of cases of maxillary empyema. As a rule, the discharge is intermittent and is affected by change of posture; in other words a position that makes the outlet of the sinus more dependent facilitates drainage. A peculiar musty odor is generally present which may be perceptible to the patient himself. The location of the pus is to some extent a guide as to its origin. Its color also is more or less distinctive, that from the antrum sometimes being light yellow or canary colored. It is probable that the variation in the physical characters of the purulent secretion in different cases is to be explained in part by the great variety of microorganisms found in these conditions. The subject has been carefully investigated by Stanculeanu and Baup, whose conclusions are interesting and may be of value with reference to determining the origin of a sinus empyema. Antral suppurations are divided into two groups. In the first there is an antecedent history of *dental* or alveolar disease and the pus has a decided fetor, due to the presence of *anaërobic* bacteria, or those whose growth is not dependent upon oxygen. The second group comprises those believed to be of *nasal* origin, the sinusitis followed an acute rhinitis, the teeth are sound and the secretion is mucopurulent and ropy. The pus is not fetid and is found to contain *aërobic* organisms, or those which grow only in the presence of oxygen. Further examination shows that microbes of the former kind inhabit the buccal cavity and are rarely found in the nose. The *aërobic* variety is met with in the nasal cavity and the purulent secretion it excites is more mucoid in character and is quite free from fetor. The *pneumococcus* either alone, or more frequently together with other microbes, is the organism most often found in the latter. In dental empyemas various bacilli may be discovered—*ramosus*, *perfringens*, *serpens*, *thetoides* and *fragilis* and *Staphylococcus parvulus* in order of frequency—all exhibiting marked virulence when injected into animals. Similar results were obtained in

investigating the frontal sinus. In one case both forms of bacteria were found, the frontal sinusitis being consecutive to an antral empyema of dental origin.

In cases of nasal suppuration in which sinus disease is suspected, the nostril having first been thoroughly cleansed of secretion, it is sometimes possible to detect a leakage of pus from the middle meatus under the concavity of the turbinate body, from which fact we infer

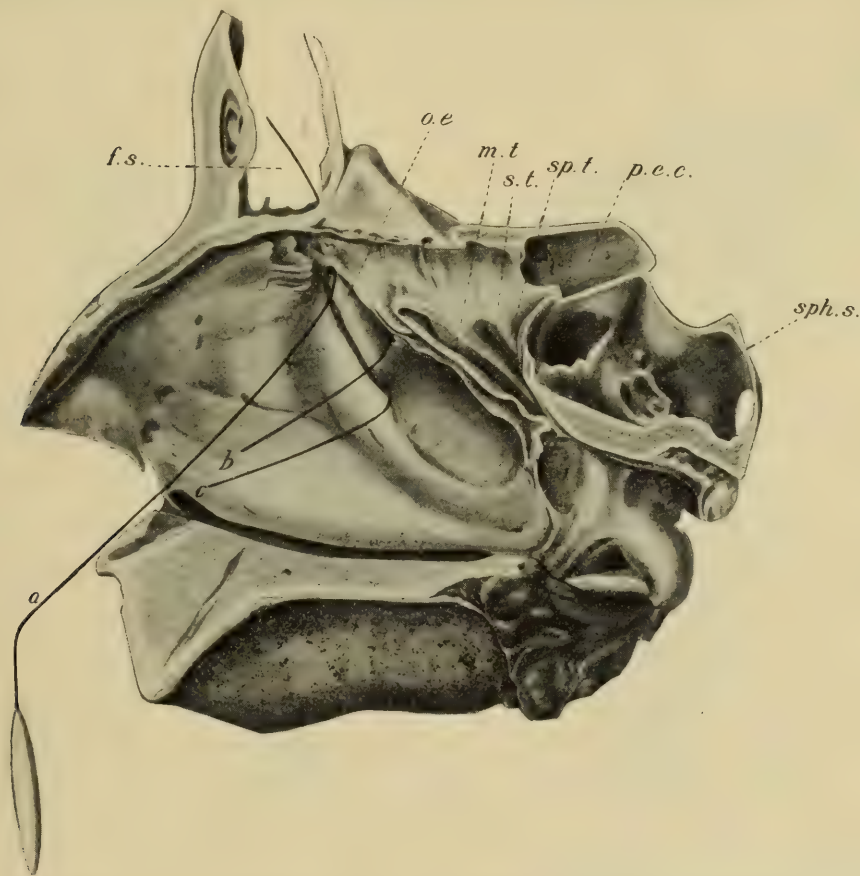


FIG. 33.—Sound in (a) Frontal, (b) Anterior Ethmoidal and (c) Maxillary Openings. (Hajek.)

f.s., Frontal sinus; *o.e.*, ostium ethmoidale; *m.t.*, middle turbinate cut off; *s.t.*, superior turbinate; *sp.t.*, supreme turbinate; *p.e.c.*, posterior ethmoidal cells; *sph.s.*, sphenoidal sinus.

an affection of either the maxillary sinus, the frontal sinus, or the anterior ethmoidal cells. If pus is seen over the convexity of the middle turbinate, or between it and the septum, it is probably flowing from the posterior ethmoidal cells or the sphenoid sinus. Escape of pus from the antrum is encouraged by directing the patient to throw the head well forward and toward the sound side. When the patient lies down the pus flows backward and causes a

bad taste in the mouth with gastric disturbance and morning nausea. The existence of polypi in the region of the middle meatus is apt to complicate an empyema of the antrum, of the frontal sinus, or of the ethmoidal cells, whether as cause or result is often hard to determine (Fig. 33).

There seems to be no doubt that the accessory sinuses are affected by an inflammatory process much more often than has been supposed until within recent years, a fact explained in part by the prevalence of crude and superficial methods of examination and in part by the obscurity of symptoms in a large proportion of cases. Very many cases are put down as "nasal catarrh," and indeed in some of long standing those affected have no complaint to make except of excess of nasal discharge. This statement is corroborated by the post-mortem researches of E. Fraenkel, Harke and others. From studies conducted at Lichtwitz's clinic, where 243 cases of sinusitis were diagnosed in 12,000 patients, and from results announced by other observers, F. Martin concludes that indications of sinusitis are fifteen times more frequent in the cadaver than in the living subject. This discrepancy is accounted for in acute cases by the relatively greater prominence during life of symptoms referable to the general disturbance and in chronic cases to the latency of symptoms located in the sinus. Post-mortem records are not to be altogether relied upon, since pus in a sinus does not always mean inflammation where the fluid is found, and moreover inflammation if present may have been a recent development in the fatal illness and hence failed to attract attention during life. The obvious lesson is that a cursory inspection of the nasal fossæ should not end the examination of a case of nasal suppuration.

THE MAXILLARY SINUS.

The antrum of Highmore, being the largest and most accessible of the sinuses, was supposed to be especially prone to suppuration until more exact and thorough methods of exploration taught us that the other adjacent cavities, notably the ethmoid cells, are involved with equal or greater frequency (Fig. 34).

An *acute* inflammation of the antrum tends to resolve under favorable conditions, that is, provided drainage through its normal outlet be adequate. The orifice of this cavity being much higher than its

floor, when the patient is erect, and liable to occlusion from swelling of the soft parts in its vicinity, an acute process is apt to degenerate into a chronic empyema. Acute maxillary sinusitis is said to be more frequent in men than in women. It may occur quite early in life. J. H. Bryan quotes Pedley as authority for a case in a child eight years old following caries of a canine tooth, and Shurly refers to a case noted by Power in a child eight weeks old due to traumatism by forceps during delivery, while Moure reports two cases in infants

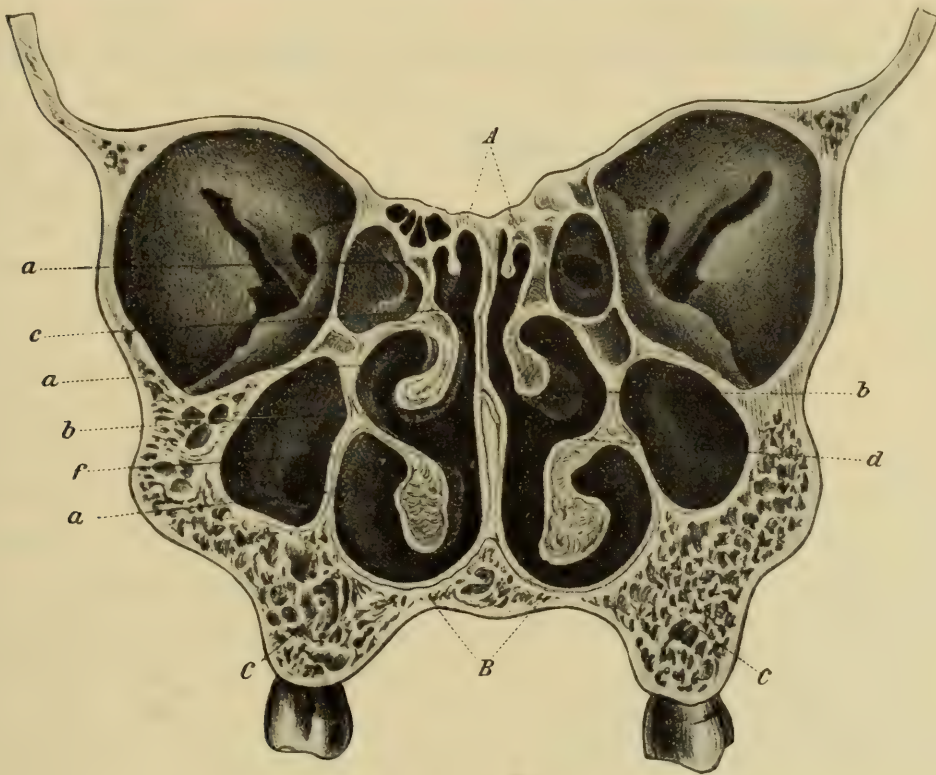


FIG. 34.—Vertical Cross Section Through Posterior Part of Nasal Fossæ Showing Their Relations to Adjacent Parts. (*Zuckerkindl.*)

A, Roof; *B*, floor, and *f* outer wall of cavity; *aaa*, superior, middle and inferior meati; *b*, middle turbinate bone; *c*, olfactory fissure, and *d*, respiratory fissure.

three weeks old from premature eruption of a tooth, one of the children being syphilitic. Bryan also describes an extension of nasal diphtheria and of phlegmonous pharyngitis to the antrum. When the inflammatory products are pent up within the cavity the symptoms are so intense as to leave no doubt about the diagnosis.

In treatment the indications are to subdue local reaction by warm applications externally and to promote drainage by reduction of swelling in the middle meatus. Cocaine, adrenal extract and sprays of

menthol usually give relief. In exceptional cases the ostium must be enlarged, the middle turbinate removed, or puncture through the inferior meatus or the canine fossa must be done. In a small proportion of cases the products of inflammation are retained in the antrum and undergo caseation. All inflammatory symptoms may have subsided, but the decomposing pus emits a most offensive odor the real source of which may not be suspected. Removal of the pus by irrigation through the normal outlet or by an artificial opening dispels the fetor (Avellis).

In looking for a cause of *chronic* empyema of the maxillary sinus it is necessary to make a careful examination both of the teeth and of the nasal chambers. It is still supposed that most of these cases may be traced to dental caries, but we have come to believe that a very large proportion owe their origin to a catarrhal inflammation affecting the middle turbinate and its neighborhood. Nevertheless, a tooth apparently sound at its crown may be a source of mischief from a carious process going on at its root. Moreover, a septic infection may be conveyed by the lymphatics from a point of decay in the crown of a tooth, the root of which is free from disease (Grünwald). M. H. Cryer, who has made careful study of this subject, believes that more teeth are lost from antral disease than primarily cause it, an opinion fully confirmed by E. S. Talbot, whose investigations have been exceptionably thorough and extensive. In other words, it is often necessary to seek a cause of antral empyema elsewhere than in the alveolus. It is sometimes possible on anterior rhinoscopy to distinguish well-marked bulging toward the nasal fossa of the outer wall of the nose. There is likely to be some swelling of the face on the affected side together with sensitiveness on pressure or percussion. It has been claimed that dullness on percussion may detect a diseased sinus and succussion has been mentioned as a diagnostic sign, but it must require an exceptionally keen ear to gain any data of value from either. In some cases, especially those of dental origin, the alveolus on the affected side is swollen, congested and sensitive to pressure. If any doubt remains as to diagnosis we may resort to exploratory puncture with a trocar, either through the inferior meatus, or the canine fossa. In the latter case an ordinary small-sized trocar and in the former the curved antrum trocar designed by Myles will be found convenient. This should be done with the strictest antiseptic precautions, lest a

sound antrum be thereby infected (Fig. 35). Hydrogen dioxide injected into the antral cavity through the ostium as proposed by Moreau Brown, is relied upon to give its characteristic effervescence in the presence of pus, but should be used cautiously, since the rapid evolution of gas may produce painful distention. Pus may sometimes be seen oozing from the antrum alongside a probe or canula passed through the ostium. With a Politzer bag attached to the canula, or air douche, one sometimes succeeds in expelling small

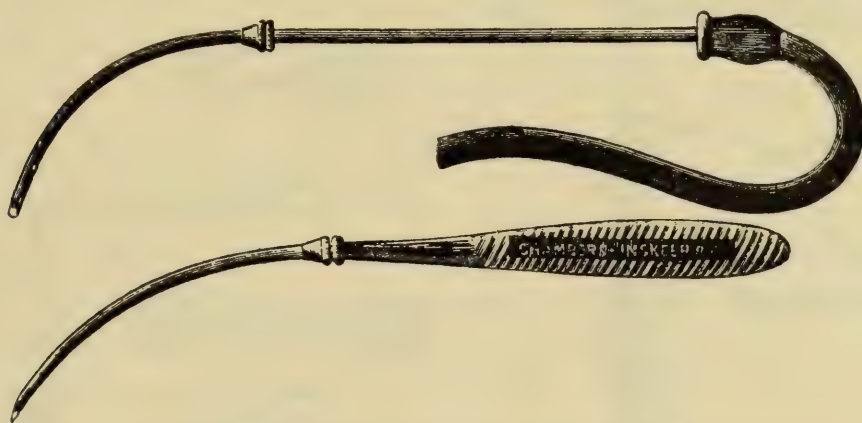


FIG. 35.—Myles' Antrum Trocar, Canula and Washing Tube.

quantities of pus that cannot be washed out by any process of irrigation. Secretion may sometimes be sucked out of an affected sinus by the process known as "negative politzerization" as recommended by Sestier. The suction method both for diagnosis and treatment has been elaborated by Sondermann and Spiess, who have devised special apparatus for the purpose. The diagnosis may be further confirmed by transillumination of the sinus by means of an electric lamp placed in the mouth (Fig. 36). It appears to have been first put to practical use by Addinell Hewson, of Philadelphia, and has more recently been investigated by Heryng and others. This test is more satisfactory in a room from which all other light is excluded. As proof of a clear antrum illumination of the face beneath the orbits is thought by Davidsohn to be less conclusive than that of the eyes, which are usually bright in a normal skull. Exploratory puncture sometimes fails, owing to extreme density of the antral wall, which the trocar cannot penetrate, or to thickness of the pus whereby it is prevented from flowing through the canula. Transillumination demonstrates the presence of pus reliably, provided we eliminate certain sources of error, but under no circumstances should its

exclusive testimony be accepted as final. By examination with the fluorescent screen even more exact information may be gained than with the ordinary electric light in transillumination, but for this special expensive appliances are required. The investigations of Zuckerkandl and others have shown that variations from the normal anatomical type are so frequent that we are liable to be led astray by certain abnormalities in the structure of the skull

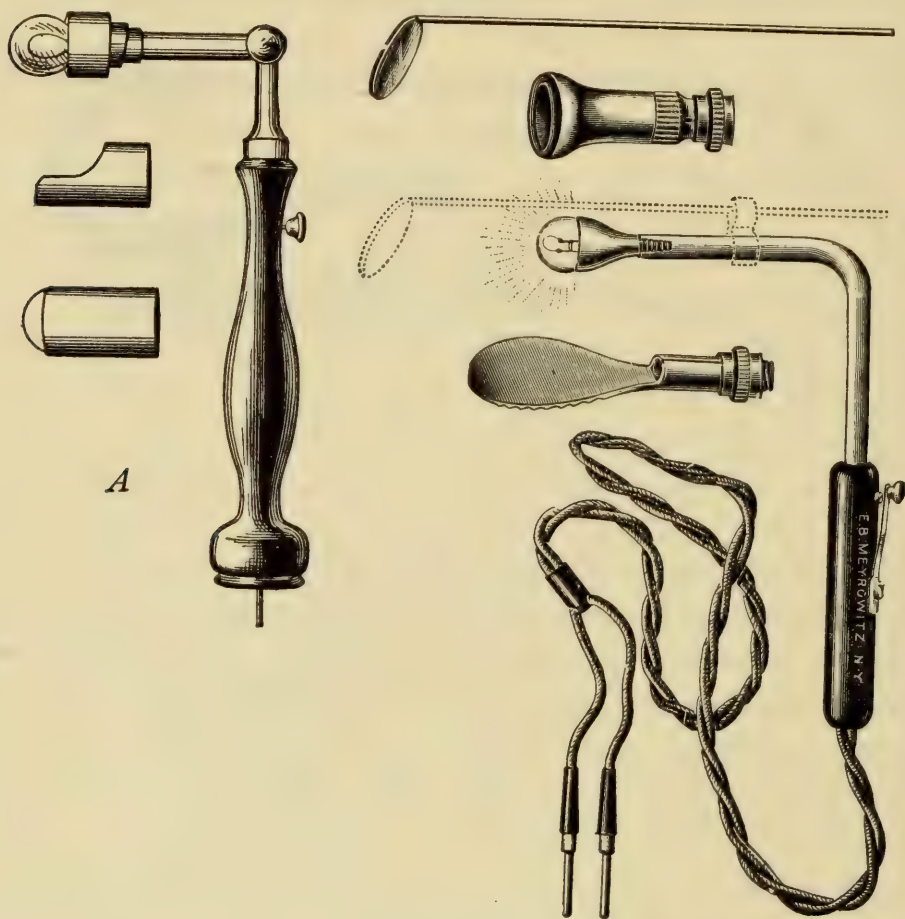


FIG. 36.—*A*, Heryng's Lamps for Transillumination; *B*, Meyrowitz' Electric Lamps.

which alter the relations and dimensions of the sinuses. The remarkable diversity in the size of the antrum in different individuals is shown by the observations of Cattlin, quoted by Heath. It is larger in the male than in the female, it contracts in old age, while in very young subjects it is extremely small or entirely absent. He also notes the fact that subdivisions of the cavity by bony ridges and that extensions of the antrum into the malar bone, the alveolus, or posteriorly are far from infrequent. Perfect symmetry is practically unknown. It is easily seen, therefore, how the accuracy of the light

test may be impaired. For instance, a relatively small antrum may transmit a deficient amount of light, as compared with the opposite side. A thickened lining membrane and anomalies in the bony wall of the antrum may interfere. The larger the antrum and the thinner its wall the more brilliant is the light test. Mucocoele and cyst of the antrum are said to exaggerate the intensity of the light. In a case of the latter under my own observations this phenomenon was obvious in consequence of expansion of the antral cavity and attenuation of its anterior wall from pressure. Until the light test was employed this was supposed to be a solid tumor in consequence of its firmness on palpation. Dentary cysts become of special interest to the rhinologist only when they invade the nasal fossa, or, as in the foregoing case, the antrum. Unless the cystic formation begins at the very root of a tooth the swelling is more likely to present itself along the alveolus, obliterating the canine fossa and finally distending the jaw and perhaps the roof of the mouth. The contents, usually thin and clear, may be reddish or coffee-colored, rarely resembling pus (F. C. Cobb). In the latter case, or if there is much inflammatory thickening of surrounding tissues, the light test may show more brilliancy on the sound side. The persistence of translucency in the presence of polypi is illustrated in a case reported, in which the antral cavity was filled with ordinary mucous polypi (Lambert Lack). In addition to the extent of the light area in the antral region, normally most intense just beneath the margin of the orbit, we may get more or less reliable information from the appearance of the pupils and from the presence or absence of perception of the flash of light on the part of the patient when his eyes are closed. In a large proportion of cases in which there is no antral anomaly the pupils are brightly illuminated and the patient is conscious of a flash when the current is passed intermittently. Having several times seen the light test frustrated by failure to remove a superior dental plate it seems not superfluous to call attention to the necessity of this precaution. The following instructive case from my clinic at the Manhattan Eye, Ear and Throat Hospital exemplifies an error into which we may be led even after the use of every diagnostic resource.

A young man was admitted with a fluctuating tumor about the size of a hickory nut at the root of the left lateral incisor of the upper jaw. It had been in existence two months and was quite painless and insensitive. There was no

history of nasal suppuration. Two years ago the jaw was injured by a fall in skating, and a carious tooth was subsequently extracted. Transillumination showed both sides of the face equally bright. With an exploring needle passed through the alveolus creamy pus was withdrawn, and on free incision the abscess appeared to communicate with the antrum. In fact the case was pronounced by several an empyema of the antrum. But on more careful examination it was possible to demonstrate that a cavity existed above this abscess and was separated from it by a firm body wall, as proved by exploration with the probe and finger. The case was one of suppurating dentary cyst, a diagnosis further confirmed by the absence of symptoms pointing to the antrum as well as of pus discharge from the nasal passages. The abscess cavity slowly filled with granulation tissue and became obliterated, but it is easy to see how the antrum might have become infected as a result of excessive surgical zeal.

The use of the tuning fork in differentiating a diseased from a healthy antrum has been proposed by D. A. Kuyk, but its practical value remains to be determined. The sound waves are said to be transmitted feebly if at all through a sinus occupied by fluid, being heard louder and longer through an empty antrum, even though of small size and enclosed by thick walls.

The source of a nasal suppuration may be determined by plugging the orifices of the sinuses in succession by means of cotton or gauze and then observing when the flow is controlled (Grünwald). In view of the difficulty in locating the anatomical outlets of the various sinuses and of the frequent anomalies in their situation this procedure is not of very practical value.

The fact must not be overlooked that even if pus is present in the antrum it may not have been generated there, since it has been proven that this cavity may act as a reservoir for pus formed in the frontal sinus or anterior ethmoidal cells. Examination is not complete until we have explored the other accessory cavities for the possible existence of suppuration in them. J. H. Bryan has described an example of direct communication of the frontal with the maxillary sinus, so that pus secreted in the former must inevitably have accumulated in the latter. He also quotes Fillebrown as having observed many cases in which the infundibulum ended below in a pocket so situated in front of the ostium maxillare as to direct a flow of pus from the frontal sinus into the antrum, the discharge not appearing in the nasal passage until the antrum and the abnormal infundibular pocket became filled. Probably some of the cases of "latent empyema" reported by Lichtwitz, Jeanty and others, re-

markable for the absence of subjective symptoms, may be explained by the existence of this anomaly. Obviously a diagnosis of suppuration originating in the maxillary antrum should not be hastily assumed.

The diagnostic features upon which we rely offer an unmistakable picture. Some or all of them may be so feebly pronounced as to justify the term "latent empyema."

The following are enumerated as the most trustworthy signs of chronic abscess of the antrum:

1. Nasal suppuration. Pus is seen flowing from the middle meatus and it is sometimes possible to exclude the ethmoid cells and the frontal sinus as sources of the discharge.

2. Pain, dull aching, or merely a feeling of tension in the antral region with more or less prominence of the face over the antrum and bulging inward of the wall of the nasal fossa.

3. Swelling, redness and sensitiveness on pressure along the alveolus on the affected side. Carious, sensitive teeth may be found.

4. Transillumination shows the suspected side in shadow, the pupil of the corresponding side is dark, and the patient himself sees less clearly or fails to see the flash of light with the eye of that side.

5. Pus may be withdrawn from the cavity of the antrum by means of an aspirating trocar passed through the ostium, the canine fossa, or the inferior nasal meatus.

In many cases of chronic sinusitis the mental depression and general disturbance are out of proportion to the activity of the process going on within the antrum. Patients often complain of neuralgia, ill-defined headaches and lack of mental concentration which are almost incapacitating. It is possible to explain such conditions by supposing an impression upon the nerve centers from more or less absorption of suppurative products. At any rate it is usual to observe improvement in these particulars after free exit has been given to the discharge and pus formation begins to subside.

The *treatment* of chronic empyema of the antrum should be conducted on general surgical principles; namely, the abscess must be thoroughly evacuated and cleansed of all diseased material. A carious tooth may protrude into the cavity, polypoid degeneration of the lining membrane, or necrosis of the bony wall may each share in perpetuating the suppurative process. Disease involving the ostium maxillare, either deflection of the septum,

nasal polypi, or enlargement of the middle turbinate in such a way as to interfere with drainage, must receive attention. A carious molar or bicuspid tooth should be extracted and the antral cavity entered along its socket. At the same time care should be taken to ensure a free opening of the anatomical outlet into the nose so as to give perfect through drainage. Sound teeth should never be sacrificed, but an opening may be made into the antrum through the canine fossa sufficiently large to admit a curette or even the



FIG. 37.—Myles' Antrum Tubes of Soft Rubber.

finger for purpose of exploration. When the antrum is entered through the socket of a tooth or a small alveolar opening it is customary to introduce a tube of soft rubber, vulcanite or silver (Fig. 37), by which the cavity is drained and irrigated. Its outer aperture is usually provided with a plug for use during eating. The anterior end of the middle turbinate, if enlarged and obstructing the middle meatus, should be removed with a snare or forceps.

Objection is sometimes made to opening the antrum through the mouth on the ground of danger of reinfection of the sinus from the buccal cavity. To obviate this the antrum may be entered by



FIG. 38.—Mikulicz's Antrum Stilet.

plunging a curved trocar, or the spear-pointed "stilet" of Mikulicz (Fig. 38), through the outer wall of the nasal fossa in the inferior meatus. Thus an aperture is made quite near the floor of the cavity. Sometimes the bone is so thick and dense as to be pierced with difficulty. A considerable portion of the wall of the meatus should be removed in order to keep the opening free. An argument against this method is that it gives us poor opportunity to explore the interior of the antrum. This is not strictly true, provided enough of the nasal wall is removed. It is to be preferred, however, because of the

relief from buccal drainage and for the further advantage that passage of food from the mouth to the sinus cavity is avoided.

In a small proportion of cases of empyema of the antrum the cavity can be entered and washed out through the natural opening. On the contrary, M. H. Cryer contends that it is impossible to enter the antrum through a normal ostium. In those cases in which we succeed in irrigating through the middle meatus the canula must have passed by an accessory opening. For this purpose a canula shaped somewhat like an Eustachian catheter, fitted with an ordinary piston syringe or rubber bulb, will be found convenient (Fig. 39). In seeking the opening in the antrum the canula should

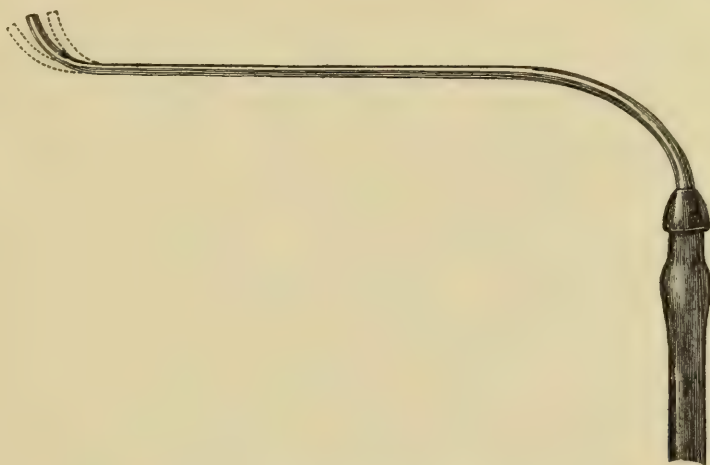


FIG. 39.—Hartmann's Canula.

be introduced with the beak directed toward the concavity of the middle turbinate and passed well back into the middle meatus. It is then turned outward and drawn forward until its tip catches in the uncinate process, when by firm pressure upward and outward we sometimes succeed in entering the antral cavity. It may be necessary to remove the tip of the turbinate, or to correct a septal deformity, in order to introduce the canula (Fig. 40).

The solution used for cleansing should be bland and unirritating. A warm 2 per cent. boric acid or normal salt solution answers as well as any. An attempt to cure antral empyema by this means should not be persisted in too long, since failure to give relief in this way in from four to six weeks is certainly indicative of degenerative changes in the mucous membrane lining the antrum or of its wall, which require to be overcome by more radical methods.

The following case illustrates how a sinusitis may be kept up by retention of a foreign body. The patient was a lady about thirty years of age who had had a molar tooth extracted. Immediately after the operation the fluid used to cleanse the mouth was observed to escape from the right nostril, indicating that the tooth had perforated the floor of the antrum. The aperture in the alveolus closed in a few days and an offensive purulent discharge from the nose appeared. About one year later the antrum was drilled through the canine fossa and irrigation practised for some weeks. The discharge ceased but recurred and the washings were resumed. The patient then went on very comfortably for a period of five years when she became rather run down in health, had frequent attacks of cold in the head and was, most of the time, conscious of an offensive odor in the nose. She suffered more or less from hemicrania and

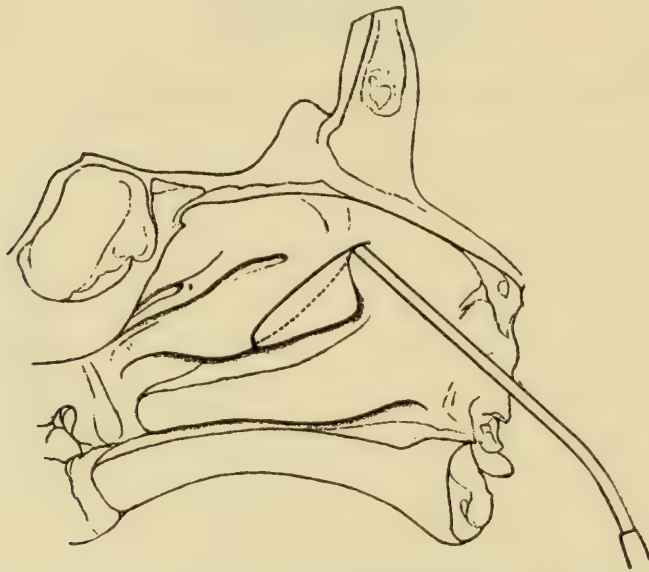


FIG. 40.—Snare Applied to Anterior End of Middle Turbinate. (*Hajek.*)

a dull aching sensation in the region of the antrum. The anterior end of the middle turbinate was removed and the antrum was syringed through the ostium maxillare. The discharge gradually ceased and remained absent for a year when it recurred with all the original symptoms. The antrum was then opened freely by A. B. Duel when a calculous mass, the size of a small bean, was found lying in the cavity. On section this proved to be the fang of a tooth encrusted with salts. The antral opening was kept free for three or four weeks; when all discharge had ceased it was allowed to close. The cure seems to have been permanent.

A similar case recorded by Macintyre is of interest especially from the fact that the foreign body, a lost drainage tube which had slipped into the antral cavity, was demonstrated with the X-rays. In doubtful cases the latter expedient may be of great value.

Many operations differing in minor details have been suggested,

but the main principles of all are to remove the cause of suppuration and provide a free outlet for pus. The latter indication is easily met; the former is effected by a course that allows complete examination of the antral cavity.

A method which has been long in use is described as the Caldwell-Luc operation. The anterior wall of the antrum is exposed by an incision along the gingivo-labial fold of the upper jaw and the muco-periosteum reflected. The bony wall is then perforated by a drill or trephine and the opening enlarged with bone-cutting forceps, until it is possible to make a thorough inspection of the interior of the cavity. Thus, the existence of trabeculæ and of areas of polypoid degeneration, as well as necrosis which would otherwise escape observation, are detected. Should conditions of this kind be discovered the cutting forceps and curette must be used with freedom, after which the cavity is washed out with an antiseptic solution and packed with iodoform gauze. The gauze is removed at the expiration of twenty-four hours, and irrigation repeated daily until suppuration ceases. Gradual contraction of the opening takes place, and, as a rule, no measures are required to close it. After a time the irrigation may be entrusted to the patient who readily learns to manipulate the syringe used for washing. In addition to a muco-periosteal alveolar flap, Luc advocates the formation of a drainage opening in the inferior nasal meatus through which the end of the gauze packing is to be brought, with the intention of closing the buccal wound by means of sutures. Practically, closure of the incision by stitching is found to be unnecessary. It is difficult to keep the wound perfectly aseptic and the stitches are apt to tear out or the wound to become infected. The parts unite readily if disturbance is avoided by care as to diet and movements of the mouth.

Removal of the anterior end of the *inferior* turbinate body is recommended as a first procedure with a view to making a large drainage opening in the *inferior* meatus. Some operators prefer to postpone this step until the close in order to avoid annoyance from bleeding. The incision in the mouth is best made from the first molar tooth forward toward the frenum and should be extensive enough to give ample space for the use of the chisel or trephine. At the moment of incising the lining membrane of the antrum free hemorrhage often occurs. It may be readily controlled by firm

pressure for a few moments with iodoform gauze. It is said to be modified by the preliminary injection of cocaine and suprarenal extract solution.

Failures in the radical operation may result from overlooking the existence of areas of polypoid degeneration, or bony septa, which partially, or completely, subdivide the antral cavity. In a case of my own a firm bony partition divided a very large antrum by projecting from its floor nearly to its roof. Without care and thorough exposure of the parts it might easily have escaped observation. The case referred to is also interesting as illustrating the condition of so-called "latent empyema" in which the symptoms were so obscure that a positive diagnosis of sinus suppuration was very tardily accepted.

The opening in the nasal fossa through the inferior meatus should be large enough to obviate the danger of premature closure. It is thus possible to dispense quite early with drainage tubes and gauze dressings, a very desirable object, since it is believed that many cases of antral suppuration are kept up by too energetic postoperative meddling.

In some cases of chronic antral disease the transillumination test shows the absence of pus immediately after operation. In most of them, however, the changes in the bony wall and mucous lining are so extensive that the light is not transmitted for several weeks, and possibly, not at all. This fact is noted by DeRoaldes, every one of a series of cases operated upon by Gordon King and himself showed opacity after a cure of the empyema had been pronounced.

The use of astringent applications to the interior of the cavity during convalescence is sometimes required. As a rule, simple cleansing by means of antiseptic irrigation is all that is necessary. Sometimes a solution of chloride of zinc, 20 per cent., or protargol solution, ten grains to the ounce, seems to assist in arresting the suppurative process. In others, the formation of pus ceases almost at once and, in from four to six weeks, a cure is established.

The *dry* treatment of sinus suppuration by insufflation with various powders, is practised with success by many. A mixture of aristol and boric acid powder is recommended by Myles, who is an adherent of the intranasal route to the antrum except when dead bone or neoplastic growth is present. The inferior turbinate is pushed aside or enough of it is resected to give free access to the

thinnest part of the nasal wall of the antrum. The structures to be avoided are the nasal duct at the anterior end of the inferior turbinate and the posterior palatine canal containing the great palatine nerve and vessels. Enough of the antral wall is removed to permit the use of a curette and the introduction of gauze packing to be removed in forty-eight hours. As a precaution against recurrence attention should be given to the condition of the nasal membranes and to the removal of any obstacle from the region of the antral orifice. It is impossible to emphasize too strongly the importance of this point, as well as the avoidance of meddlesome interference with a reparative process by excessive irrigation with strong solutions, or by plugging the antral cavity with sterilized or medicated gauze for too long a period.

In most cases an alveolar opening into the antrum gradually contracts. Occasionally its closure has to be encouraged by cauterization. In exceptional cases a permanent fistula remains, and it has been my experience to see several such cases in which the condition caused little or no inconvenience. The continuance of discharge after operation is explained by complications which have already been adverted to, namely, the persistence of pyogenic membrane in a pocket or adventitious sinus overlooked at the time of operation, or the presence of some neglected nasal anomaly, or finally the fact that the antrum is acting as a receptacle for pus overflowing from the frontal sinus or the ethmoidal cells. Moreover, the influence of the general health upon a suppurative process should be remembered, and if indicated measures tending to improvement in that direction should be adopted.

FRONTAL SINUS.

Inflammation of the frontal sinus is a frequent complication of an acute coryza and is prone to lapse into a chronic condition in the presence of any occlusion of the *hiatus frontalis*. One of the earliest symptoms in acute cases is pain in the supraorbital region on the affected side. In a small proportion of cases there is but one frontal sinus, no median septum being present (Fig. 41). An exceedingly rare condition has been described by Suarez de Mendoza, in which two sinuses on either side, one behind the other, were found. They communicated by small openings with each other and each opened

into the nose by a separate passage. Such an anomaly might render its possessor more prone to sinus disease, and it is easily seen that any therapeutic measures, surgical or other, are thereby made more difficult and complicated. Pain may be intense, neuralgic in character, aggravated by blowing the nose, or a stooping position, or it may consist of simply an aching sensation, or a sense of dullness or weight. There is marked tenderness along the supraorbital ridge and especially on deep pressure under the supraorbital arch. Frequently there are puffiness and swelling of the skin over the affected



FIG. 41.—Normal Frontal Sinuses of Average Size. (*Logan Turner.*)

sinus and of the upper eyelid, and sometimes slight pitting under compression. These symptoms subside with the occurrence of a purulent nasal discharge, or distention of the cavity may be followed by exophthalmos and formation of an orbital abscess.

The diagnosis based on the foregoing symptoms is usually free from difficulty. Transillumination offers a less reliable diagnostic sign in case of the frontal sinus than with the antrum owing to the well-known fact that asymmetry of the former is much more frequent (Fig. 42). A small electric lamp, covered except at its end by an opaque shield, pressed well under the supraorbital arch, defines the boundaries of the frontal sinus quite accurately. By using a lamp on either side simultaneously, or a double transluminator like that devised by H. S. Birkett, it is possible to compare the sinuses

by illuminating both at the same moment. Thus the rays of light are thrown upward through the floor of the sinus. The single lamp being placed at various points on the forehead, meanwhile the patient being directed to keep his eyes closed, he himself can map out the sinuses with considerable precision by noticing when the light becomes perceptible as it is shifted about. By what they call "medio-frontal" illumination, Lubet-Barbon and Furet have demonstrated that by placing the lamp in the median line of the forehead a difference in intensity of the light may be observed under

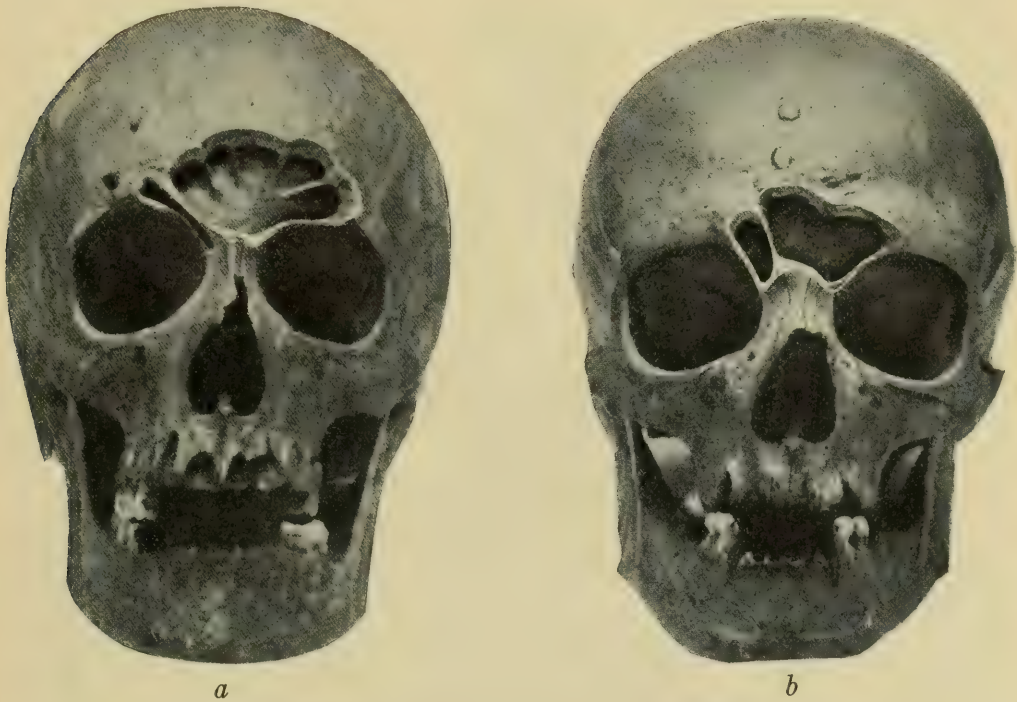


FIG. 42.—Asymmetry of Frontal Sinus.

a, Right sinus almost obliterated and left subdivided by numerous septa; *b*, small right and very large left sinus. (*Logan Turner.*)

the supraorbital arch. Logan Turner, whose researches in this field have been very complete, finds many interesting anomalies and variations in the frontal sinuses and concludes that the light test is of little or no practical value in chronic suppuration in these cavities, his view being based on the following grounds: "(1) One or both sinuses may be absent, and when this anatomical condition exists, there is opacity on one or both sides of the skull. (2) A certain proportion of healthy sinuses fail to illuminate; this may occur on one or on both sides of the skull. (3) A sinus on one side of the skull may illuminate with less brilliancy than its fellow, although

both are perfectly normal. (4) Many sinuses containing pus, and with their mucous membrane thickened and often polypoid, illuminate with considerable intensity." Darkness may indicate no sinus, a thick walled sinus, or a diseased sinus, so that in most cases we must arrive at a diagnosis by other means. The absence of subjective symptoms may necessitate reaching an opinion by exclusion. If pus quickly reappears in the middle meatus, the antrum having been emptied of purulent contents by syringing through the

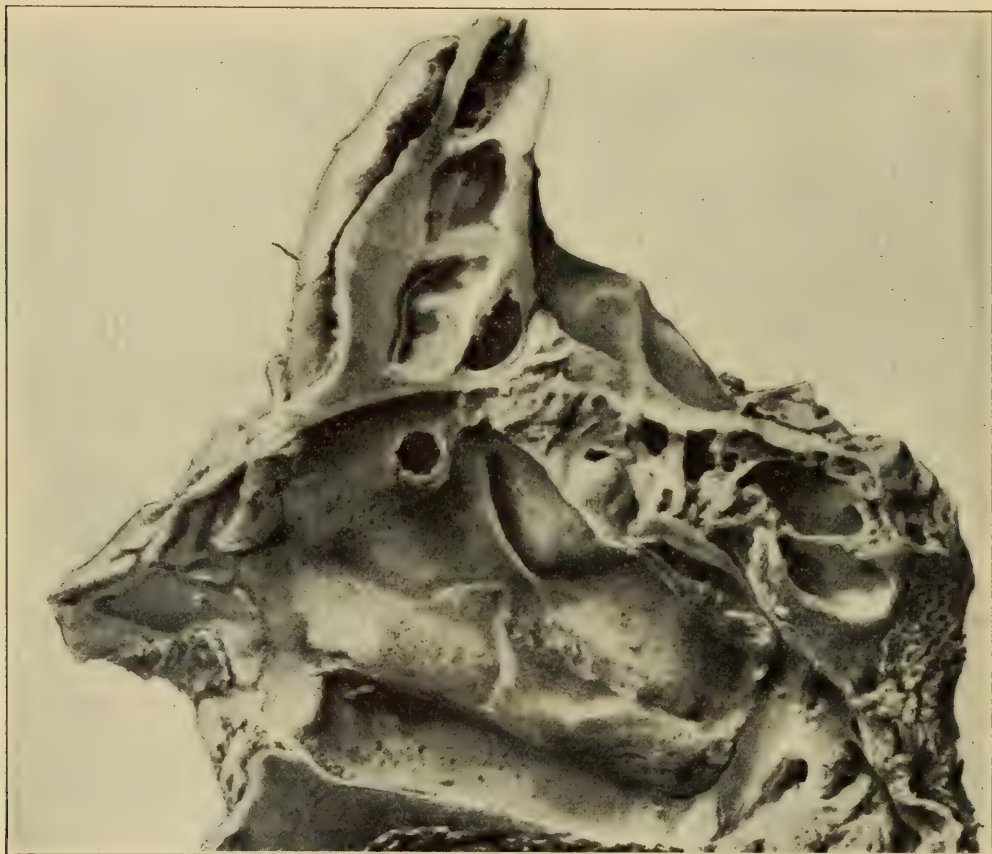


FIG. 43.—Septa of Frontal and Sphenoidal Sinuses. (*Schadle.*)

ostium and the patient's head being held quite erect, the source of pus must be either the frontal sinus or the anterior ethmoidal cells. Even in so-called "latent" cases a certain degree of tenderness on the affected side is elicited by firm pressure upward against the floor of the sinus. In cases of the latter class also there is apt to be at times more or less external swelling in the region of the sinus. In some cases a positive diagnosis can be made only by catheterizing the sinus through the frontonasal canal with a Hartmann or Krause

canula, a feat often very difficult of accomplishment. The passage may be tortuous, or it may be necessary to resect the anterior end of the middle turbinate or other obstacle before a probe or canula can be passed. The end of the probe may become engaged in an anterior or fronto-ethmoidal cell, or may be arrested by an irregularity in the canal, but if it seems to have some freedom of movement and has passed a distance of not less than six or seven centimeters from the floor of the nose the presumption is that it has entered the sinus (Fig. 43).

The experiments of Onodi, Coakley, Mosher and others show that skiagraphy gives most valuable information as to dimensions of the sinuses. The existence of septa, recesses, and somewhat less clearly of inflammatory products may be demonstrated.

In the *treatment* of a frontal empyema the first essential is the correction of any lesion or obstruction in the nostril. The tendency to spontaneous cure is certainly more pronounced than with the other accessory sinuses provided drainage through the anatomical outlet can be restored. If the case is allowed to pursue its own course discharge of the abscess may take place into the middle meatus through the frontonasal canal, or it may rupture into the orbit where the wall of the sinus is thinnest, outward through the external table, or through the inner table into the cerebral cavity. In a case of long standing which occurred in my own clinic the abscess pointed at the outer limit of the superciliary ridge; in the meantime by pressure upon the eyeball producing symptoms which had led the patient to consult an oculist. The abscess was opened by free incision when the nature of the case was demonstrated. The best method of treating a *chronic* frontal sinusitis is by external operation which leaves more or less of a scar but gives reasonable assurance of cure. In attempting the relief of the case through the nose we are handicapped by being obliged to work in a very narrow passage and, moreover, opportunity is not given to make proper exploration of the sinus cavity. Indeed it is difficult to enter the sinus by passing a probe along the frontonasal duct. One is quite as likely to get into the anterior, or fronto-ethmoidal cells, or even altogether fail to find the orifice of a canal. The latter has been the experience of more than one operator after complete extirpation of the middle turbinate body. Great assistance may be derived from the X-ray both in guiding the probe and in directing the drill in enlarging

the nasofrontal duct. According to Spiess the diameter of the drill should not exceed three millimeters. An additional safeguard is provided in the "pilot burr" of Ingals, an instrument intended to prevent deviation of the drill from its proper channel. This authority, who is a most confident advocate of the endonasal route, has had excellent results. While the dangers of attempting to enter the sinus through the nasal fossa may be eliminated by his method it would seem impossible to reach all the foci of suppuration in an irregular sinus or one complicated by an ethmoiditis. It must be admitted also that a perfect cure is not always attainable by a so-called radical external operation. Symptoms due to tension from pent-up secretions are relieved but suppuration does not cease. At the present time the conclusion seems to be justified that only simple uncomplicated cases are suitable for the endonasal operation. Doubtful cases of multiple sinusitis of long duration are likely to yield if at all to a mode of attack that allows removal of all diseased tissue as well as gives free drainage.

In most cases the lining membrane has undergone a degenerative process which necessitates thorough curettage, or caries or necrosis of bone may have taken place. Under such circumstances simple drainage is not sufficient to accomplish a cure and the only rational mode of treatment is to make free exposure of the cavity by what is known as the Ogston operation, or one of its modifications. As carried out by Luc it is thought to be especially appropriate for an empyema comparatively recent, in a sinus of medium size and not complicated by ethmoidal disease. An incision is made from the supraorbital notch toward the middle line, including the skin and periosteum, which are then reflected and the anterior wall of the sinus is opened by means of a trephine, hand drill, or chisel. If more room is needed a vertical incision is made in the median line at an angle with the first. Sufficient bone should be removed by means of cutting forceps to enable one to explore the walls of the cavity thoroughly and to pass a drainage tube through the frontonasal duct into the nasal fossa. The cavity having been thoroughly cleansed and irrigated, the external wound is closed with sutures, a drainage tube being passed through the nasal opening. So long as signs of suppuration appear with the irrigating fluid used for washing the cavity the tube should be retained. Usually in the course of a week or ten days it may be safely withdrawn.

Various modifications of the original operation for frontal sinus disease as proposed by Ogston have been suggested. Removal of the anterior wall and of more or less of the floor of the sinus, as in the operation performed by Kuhnt, gives an excellent exposure and the cavity at length becomes filled with granulation tissue and orbital fat. As in all operations involving the floor of the sinus derangement of the eye may follow, but it is usually temporary. Diplopia from disturbance of the pulley of the superior oblique and iritis are the most common. The former is avoidable and the latter may be prevented by the use of atropin. By this method the ethmoid labyrinth is brought within reach and trabeculae and diverticula of the sinus are much less likely to be overlooked, but the resulting deformity is certainly greater. A liberal opening is made into the nasal fossa and the external wound is completely closed. Nevertheless, the wound may become infected and fail to unite, and in consequence an ugly retracting scar results. In contrast with the foregoing is the "open" operation advocated by Curtis and Coakley, in which an attempt is made to shut off the nasal cavity and drainage is effected by way of the forehead wound. A sinus of moderate size is thus finally obliterated. Various expedients have been suggested to prevent or correct disfigurement. In a modification proposed by R. W. Payne, several openings are made into the affected sinus, intermediate bridges of bone being left to serve as a supporting framework to the soft parts. The insertion of a plate of aluminum, platinum, decalcified bone, or ivory to lessen the disfigurement has been suggested by Semon. Paraffin prosthesis is likely to prove useful in this direction. A most excellent result was thus obtained by Curtis who dissected out a disfiguring operative scar and sutured the wound over a mass of paraffin ("paraffin cast") entirely filling the sinus cavity. It remains to be seen whether such a large amount of paraffin will permanently retain its shape.

The following method of operating is described by Lothrop (Fig. 44). A curved incision is made from near the nasofrontal suture upward parallel with the folds of the skin formed by the corrugator supercilii muscle for about fifteen millimeters, gradually curving outward and following the horizontal folds. With a drill or trephine an opening is made at the inner angle of the orbit and below the inner extremity of the superciliary ridge. According

to Lothrop the existence of a diploë in this situation may be relied upon to show the absence of a frontal sinus, and none being found pus, if present, must come from the ethmoid cells. In several instances to the author's knowledge both cancellated tissue and sinus have been absent. In one hundred crania examined by Max Scheier the frontal sinus was absent five times, and other anomalies were frequent.

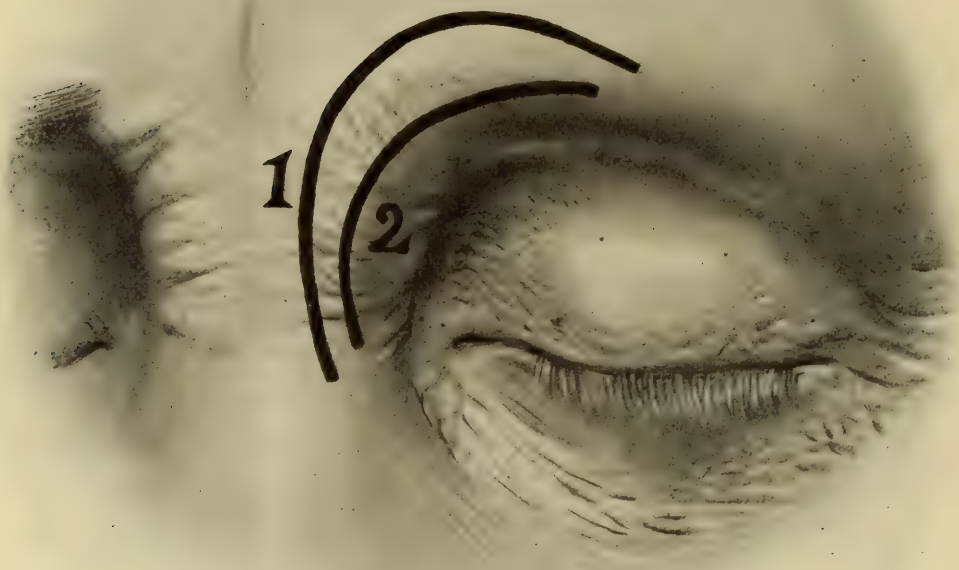


FIG. 44.—Incisions in Opening Frontal Sinus. (Lothrop.)

1, Anterior wall. Osteoplastic operation, the bone flap thus formed is deflected downward. 2, Floor, giving access also to ethmoidal cells.

Through the opening thus formed the cavity is probed to determine its dimensions and possible changes in its mucous lining. If the sinus is found to be very spacious, the opening must be enlarged by chiseling a bone flap along the line of incision with the supra-orbital arch serving as a base. This bone flap may readily be pried downward and fractured along the thin orbital wall of the sinus and is to be replaced at the conclusion of the operation. The advan-

tages claimed for this method are that the sinus may be well opened and that a large opening may be made into the nasal fossa without disturbing the orbit. Several other osteoplastic operations with a similar end in view have been offered. In that of Hajek, the bone flap is formed from the anterior wall and reflected upward. In an operation recently described by J. C. Beck a skin flap is reflected from below upward. The dimensions of the sinus having been accurately defined by a celluloid tracing of a radiogram, a bone flap is made to conform strictly with the outline of the celluloid model. The bone is penetrated above sufficiently to admit a Gigli saw directed downward to the level of the supraorbital ridge. The osteoperiosteal flap thus formed is everted downward to the bridge of the nose completely exposing the interior of the sinus. Free nasal drainage is provided for by enlarging the nasofrontal duct and removing the anterior ethmoidal cells. The parts having been replaced the external wound is sealed. This is called a "conservative" operation by its author, perhaps because he prohibits the free use of the curette, although he removes diseased mucous membrane. All these methods are open to the objection that the sinus is more or less liable to reinfection, since it has not been effaced.

The frontal sinus may also be entered through its *inferior* wall, giving a less perfect exposure of the cavity but rendering the ethmoid cells accessible and being followed by somewhat less deformity. Without the exercise of great care there is, however, more danger of disturbing the orbit or interfering with the lachrymal apparatus. This is sometimes known as Jansen's operation. The objection to it last mentioned is very serious while it is by no means absolutely free from disfiguring effects.

In this operation the incision commences opposite the inner canthus, in front of the margin of the orbit, over the nasal process of the superior maxilla. It curves upward and outward along the eyebrow to the supraorbital notch. The periosteum is elevated and the flap turned down so as to expose the internal angular process of the frontal bone. Hemorrhage may occur from the supraorbital and angular arteries and may be controlled by pressure or by ligation. The bony wall of the sinus is opened by means of the chisel just above the internal angular process of the frontal bone where the bone is thinner than on the anterior surface and more easily perforated. If pus escapes through the operative wound at once we

have reason to believe that the frontal sinus is affected; if not, the presumption is that suppuration arises from the ethmoid cells which may be easily reached through this wound. The most important step in these operations is the establishment of roomy communication with the nasal fossa by removal of the anterior ethmoid cells. A small probe is passed through the ostium into the nose to be used as a guide. The finger may be introduced into the nostril in order to give the curette the right direction, which should be downward and somewhat backward. Practically, this consists in removal of a greater part of the lateral mass of the ethmoid which fills in the meatus frontalis and, if thorough, no drainage tube will be required. The external wound is closed completely and protected with a sterile dressing and the nostril is packed with iodoform gauze for twenty-four hours.

In the after-treatment irrigation of the nasal fossa should be gentle so as to avoid disturbing the wound in the skin and should be limited to a warm 2 per cent. boric acid solution. The patient should be especially warned not to blow the nose until the wound is thoroughly healed.

Sometimes the external wound fails to unite completely, especially in cases of extensive disease of the sinus or of bone involvement. As a rule, however, union takes place kindly and the relief of symptoms attributable to pressure is almost immediate.

The most extensive and radical operation now in vogue on the frontal sinus is that planned by Killian. But few dissent from the opinion that it is the best for large sinuses and complicated cases, while its promoter claims that it is suited to *all* cases of frontal empyema. The anterior wall and floor of the sinus and the frontal process of the superior maxilla are removed leaving a supporting bridge of bone along the supraorbital margin. Thus the entire cavity and the ethmoid cells are well laid open and it is hardly possible to miss a focus of suppuration. The skin incision extends from the temporal end of the eyebrow to the root of the nose, thence curving downward to the base of the nasal bone. The osseous bridge is outlined by one incision through the periosteum corresponding with that in the skin and a second, the skin alone having been raised, parallel with and 5 to 6 cm. above the first. Above the latter the bone is well bared of skin and periosteum to the limits of the sinus, which is then opened near the median line. Great

stress is laid by Freudenthal upon the importance of entering the sinus *below* the bridge near the inner canthus rather than on the forehead. Several cases have been reported in which the operator was misled as to the dimensions of the sinus, but the accurate outline apparently given by the skiagraph should protect us from the danger of opening the cranial fossa. The frontal process and the floor seem to be most easily reached by stripping up the soft parts through the line of the lower periosteal incision. In this region great care must be taken to avoid damage to the eye. The chisel, Hartmann's forceps, and in the ethmoid region Volkmann's spoon are the instruments preferred for attacking the bone. The operative field is prepared by thorough washing with alcohol and an antiseptic solution, but it is not thought necessary to shave the eyebrow. The posterior nares are plugged until it becomes evident that the ethmoid cells must be extirpated. All morbid tissues having been removed, the parts are irrigated with warm saline solution and the external wound carefully sutured. A drainage tube is carried from the outer end of the external incision to the anterior naris and held in place by a nasal tampon which at the same time supports the flap of mucous membrane which covered the middle turbinate bone, in case that structure has been removed together with the ethmoid cells. The dressings are changed daily and the tube dispensed with after the third or fourth day. No irrigation or flushing of the nasal cavity is permitted and the patient is forbidden to blow the nose. The external dressings consist of a light gauze pad over the eye, in which, as a precaution against iritis, atropin has been instilled, and a firm bandage to the forehead to keep the scalp in contact with the posterior wall of the sinus (Luc). It is advisable to bevel the bone at the upper margin of the wound so that the skin flap may be adjusted smoothly. The weak point lies behind the inner end of the supraorbital bridge where secretion may persist and collect unless ample drainage space is provided in the frontonasal region (Logan Turner). In view of the comparative infrequency of ethmoid disease as a complication of frontal empyema, *i.e.*, 62 per cent. according to Turner's statistics, the need of general resort to this rather formidable procedure is in doubt. Yet it must be admitted that the mortality and the calls for secondary operation have been less frequent with the obliterative than with other methods of operating.

The question as to whether a radical external operation should be advised in a given case is not always easy to answer. By no means every case thus handled gets well, if by that we mean absolute cessation of pus discharge. On the other hand, the appearance of pus in the middle meatus known to proceed from the frontal sinus is far from being an indication for immediate external operation. Continued difficulty in concentrating the mind, constant headache associated with frontal suppuration and more or less nasal obstruction may be accepted as indications for radical interference, in case intranasal methods have already failed, and provided the patient is willing to submit to probable disfigurement and at the same time take the chance of incomplete relief. Post-operative fatalities have been numerous enough to show that details of technic have not yet been perfected, and place this surgical procedure in the list of capital operations which should not be undertaken without due consideration.

ETHMOID CELLS.

Almost every writer on the subject has his own arrangement of the morbid conditions affecting the ethmoid region, based either on a pathological hypothesis or on clinical history. Most of the former are more or less erroneous while the latter are apt to be confusingly elaborate. In view of the frequency of ethmoid disease it is rather surprising that such extreme difference of opinion should prevail as to its origin and nature. Bosworth regards ethmoiditis as the most common form of sinus inflammation, while the post-mortem records of Lapalle show the occurrence of ethmoidal empyema only six times, frontal five, sphenoidal nineteen and maxillary forty-eight times in fifty-five cases of sinus disease. In every instance empyema of other sinuses coexisted—the maxillary five times, the sphenoidal four times and the frontal twice. An ethmoiditis may be latent, that is, it is disclosed by no well-defined objective symptoms, or it may be attended by free pus discharge the source of which is obvious. It may be obscured by the concurrence of mucous polypi, not only in the nasal fossæ but even within the cells, and by orbital abscess. The latter complication is certainly very infrequent in this country. The middle turbinate bone may be in a state of bulbous or cystic expansion (*concha bullosa*),

the ethmoid cells being enormously distended, and their bony walls fragile and more or less carious. Spiculæ of bone are found in the discharges and the existence of necrosis may be determined by exploration with the probe or the finger. Empyema of the ethmoid cells occurs without regard to sex or age. Cases of orbital abscess have been reported as a rule in young subjects.

The causative relations of ethmoiditis and of sinus disease in general to atrophic rhinitis, or "ozena," as some writers persist in calling it, a theory especially advocated by Grünwald, and to nasal polypi have been fertile topics of debate. Bresgen found empyema of the maxillary sinus or of the ethmoid cells in eleven cases of atrophic rhinitis, Moure in 32 out of 114 cases, while Jacques and George firmly maintain the causative relation of sinus disease to atrophy and assert that implication of the sphenoidal sinus and ethmoid cells most frequently preëxists. The relation of sinus disease to nasal polypi will be discussed at length in the chapter relating to the latter.

A rather rare condition of some interest but fortunately not of very serious import—emphysema of the eyelid—has been described by Beaman Douglass. It may occur as a result of disease of the ethmoid cells or of injury to them in operating. As a consequence of violent blowing of the nose after a laceration of the lachrymal duct or of a compound fracture of the nasal bones it does not concern us in this connection. The upper lid rather than the lower is invaded, the air finding its way from the ethmoid cells through the wall of the orbit and forward along the fascia which separates the extrinsic muscles of the eyeball from the intrinsic. The accident is indicated by the occurrence of sharp pain in the orbital region, immediate swelling of the lid and more or less displacement or protrusion of the eyeball. Usually the air is absorbed and the parts resume their normal appearance in a few days with the exception perhaps of some degree of ecchymosis. With a view to avoiding this accident the use of a small blunt-edged forceps instead of a curette in the ethmoid region is recommended as being less likely to perforate the lamina papyracea.

Inflammation of the ethmoid cells may be catarrhal or suppurative. The former often accompanies an acute rhinitis and subsides as the latter disappears, or may degenerate into a purulent process.

Suppuration of the ethmoid cells may be acute or chronic, the

former owing to the anatomical construction of the parts tending to develop into the latter. In some cases the only symptom is a discharge of pus from the nostril. If the anterior group of cells only, or the fronto-ethmoid cells, is affected pus appears in the middle meatus; if the posterior group is diseased pus spreads over the septal surface of the middle turbinate body and finds its way backward to the nasopharynx. The tendency to spontaneous recovery is slight in ethmoid disease and in addition to the pus discharge certain other symptoms are characteristic. Pain is usually deep seated and is frequently referred to the bridge of the nose or the postorbital region. Occasionally mixed with the pus bits of carious bone are detected. When the bone is affected crepitation is sometimes elicited by firm pressure at the inner angle of the orbit. Even in the absence of pus there is a peculiar sickening odor, and when necrosis is in progress there is added the characteristic necrotic odor. There may be ocular disturbance, exophthalmos and contraction of the visual field from pressure upon the orbit, and where there is a great deal of intracellular mischief much distress may result from distention of the ethmoid cells and intranasal pressure. The sense of smell is more or less impaired or perverted, the patient himself complaining of *kakosmia*. Indications of septic infection may be exhibited in febrile reaction and general systemic depression. In aggravated cases symptoms of meningitis develop. In fortunate cases the pus is discharged into the nasal chamber; in others, it may open at the inner angle of the orbit. It may reach the antrum or frontal sinus or, in its worst phase, it may penetrate the anterior cerebral fossa and induce a fatal meningitis.

A diagnosis must often be reached by exclusion. In cases in which the foregoing symptoms are pronounced there should be no difficulty in defining the condition; but in others the symptoms are so obscure as to leave the case a long time in doubt.

A serious prognosis must be given unless free intranasal drainage is established. Fortunately this is usually feasible, but while pus formation is active the patient is not absolutely out of danger. Kuhnt has recorded seventeen cases of fatal meningitis consecutive to sinus disease, a number large enough to serve as a warning against neglect of this condition.

Treatment, in cases of moderate severity, consists in free opening of the ethmoid cells through the nostril by means of cutting forceps,

drill or curette and the subsequent thorough cleansing of the parts with an antiseptic solution (Fig. 45). A nasal deformity which interferes with drainage should be corrected. The possibility of other sinuses being involved should not be overlooked. Complication of the case by the existence of nasal polyps is very frequent and they,

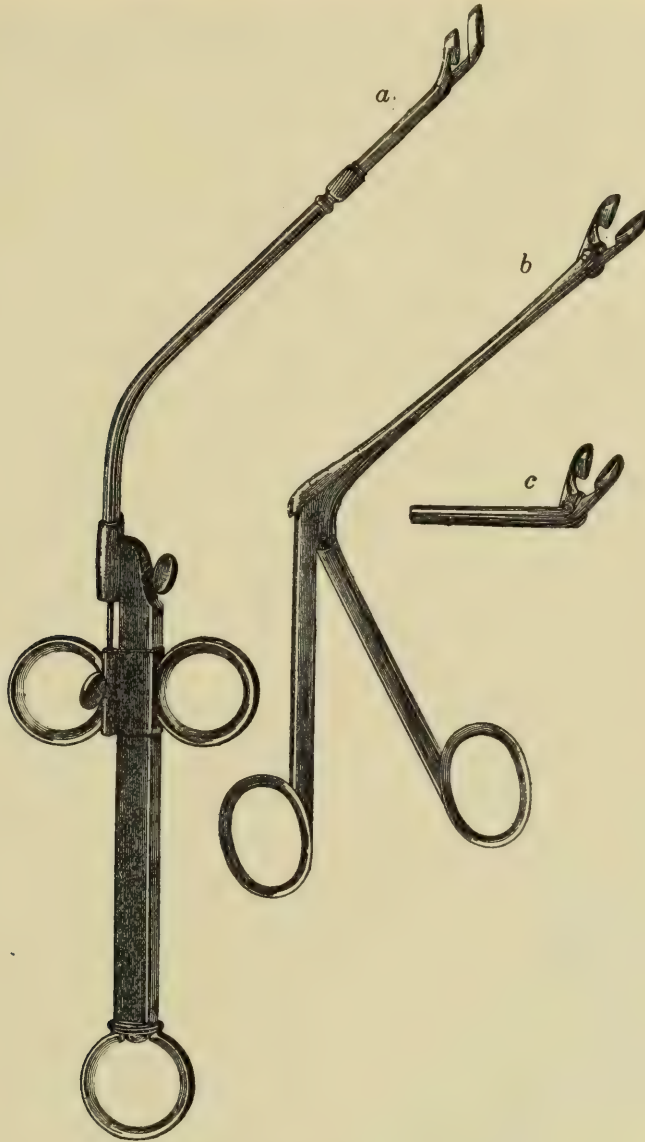


FIG. 45.—*a*, Hajek's double curette; *b*, *c*, Grünwald's cutting forceps.

as well as excessive granulation tissue and necrotic bone, should be removed. These operative procedures upon the ethmoid are usually done under local anesthesia with cocaine. Careful examination with the probe for the detection of spiculæ of bone should be practised and the case be kept under close watch as long as suppuration continues.

The anterior ethmoidal cells are situated in the upper part of the ethmoid and fill in the floor of the frontal sinus. Most of them are large and many have their walls completed by articulation with neighboring bones. They are very numerous and suppuration involving them is liable to be transmitted to the frontal sinus.

Such being the case the operation which has just been described is applicable only to disease limited in extent and in an unusually wide nasal chamber. In cases of long standing nearly all the ethmoid cells are involved and a very large portion of them are quite inaccessible through the nasal fossa. In attempting to curette the field of operation is almost immediately obscured by hemorrhage, so that we run the risk of carrying our instrument in an improper direction or too far, thus either invading the orbital cavity or possibly perforating the cribriform plate and entering the cerebral fossa itself. About all that can be done by the nasal method of treating ethmoiditis is to remove the middle turbinate including the cell which sometimes exists in its body and curette the cells in its immediate neighborhood. When relief is not obtained by this means an external operation is the only safe and radical mode of treatment. An external incision along the inner angle of the orbital ridge at the level of that practised for opening the frontal sinus is recommended. By this incision the floor of the frontal sinus is exposed and the ethmoidal region is brought within easy reach. All the cells can be thoroughly curetted and an opening made into the nasal cavity for drainage, so large that no drainage tube is required. If necessary the posterior group of cells may also be attacked by this route. The external wound, after thorough cleansing and sterilizing of the cavity, is closed as in the operation for frontal sinus disease. Usually the wound heals without much disfigurement, provided it be carefully sutured and nasal drainage be adequate. Care should be taken in irrigating the nasal fossa to use no violence in order that the wound may not be disturbed.

The more formidable operation just described is called for very exceptionally. In the majority of cases the patient will be content with the relief given by opening and draining the cells through the nose, even though the disease cannot be thus completely suppressed.

SPHENOIDAL SINUS.

Inflammation of the sphenoidal sinus is less rare than has been hitherto supposed. The causes acting to produce disease here are similar to those that prevail with reference to the other

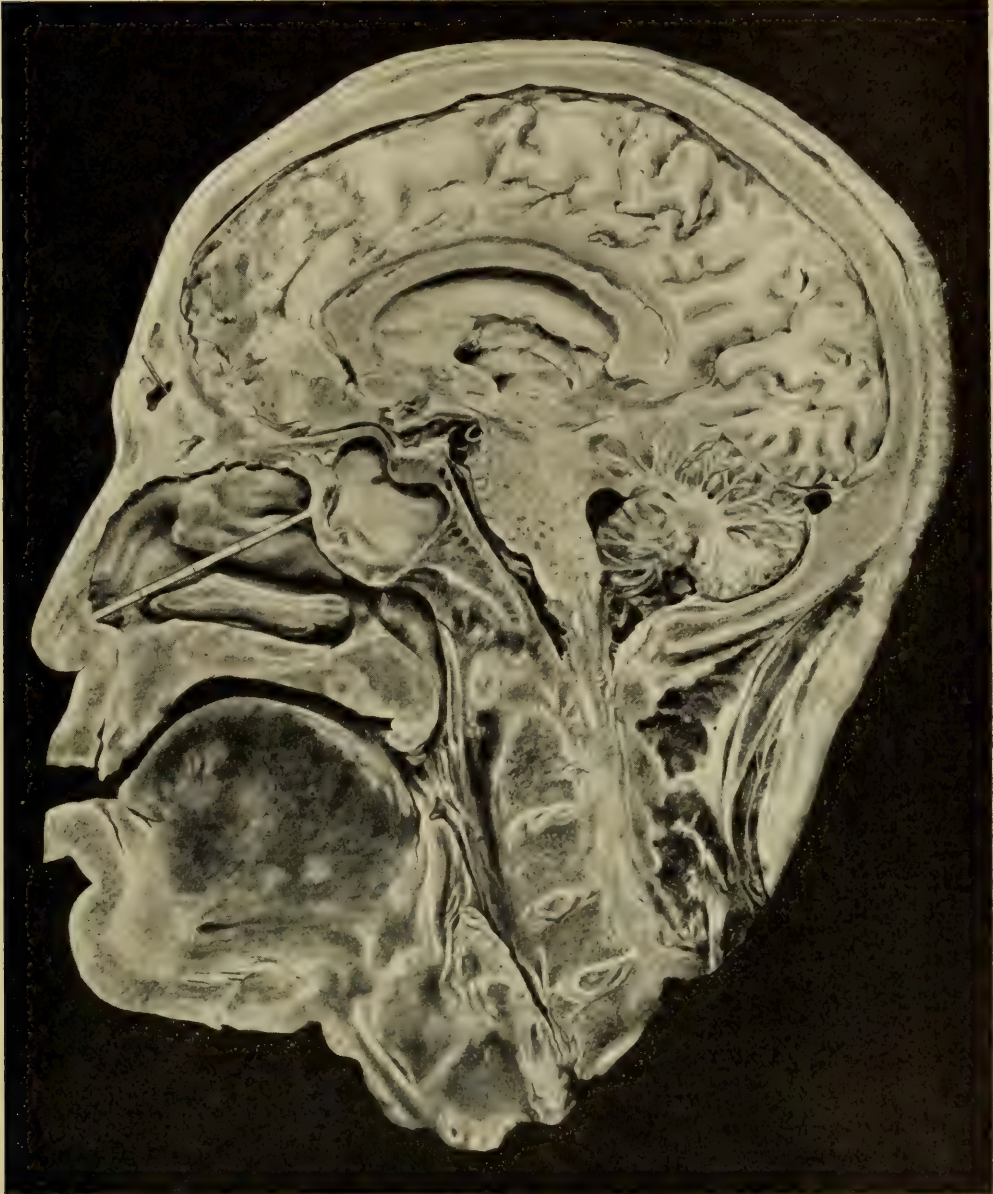


FIG. 46.—Probe in Orifice of Sphenoidal Sinus Showing Distance from Nasal Vestibule, about 2 $\frac{1}{2}$ inches. (*Bryan.*)

Sieur and Jacob profess to be able to catheterize the sphenoidal ostium by passing a curved instrument close to the dorsum of the nose and the under surface of the cribriform plate, instead of going obliquely across the middle turbinate.

sinuses, and the pathological changes resemble those occurring elsewhere. The opening of the sphenoidal sinus is so situated as to

impede the free escape of secretion. It may sometimes be found by passing a probe obliquely upward across the middle turbinate body and close to the septum (Fig. 46). The pus secreted in sphenoidal sinusitis usually flows backward into the pharynx or spreads over the posterior end of the inferior and middle turbinates. No doubt many cases of so-called postnasal catarrh are really examples of sphenoidal inflammation. The pain often referred to the occiput is of an aching character and may be intense and radiating. Ocular symptoms are very apt to develop in sphenoidal disease from involvement of the trigeminus. Impairment or loss of sight and exophthalmos have been observed. In a case under my own care marked ptosis was a prominent symptom which disappeared as the inflammatory signs subsided. It is seldom possible by rhinoscopy, either anterior or posterior, to determine definitely the origin of the pus; that is, it cannot be seen actually flowing from the sinus except in certain cases of atrophy or deviated septum. In general pus from the sphenoidal sinus inclines to spread out over the vault of the pharynx. It may be impossible to tell whether the discharge comes from the sphenoidal sinus or the pharyngeal bursa, suppuration of which, under the name of Tornwaldt's disease, is occasionally observed.

The prognosis in sphenoidal sinusitis is less favorable than that of inflammation of other sinuses owing to the difficulty of reaching the cavity. Extension of the disease to the orbit or meninges may occur with fatal results. A case of erosion of the cavernous sinus and fatal hemorrhage has been reported and others of thrombosis involving the circular and cavernous sinuses and the ophthalmic veins have been recorded. An extraordinary case in which the whole body of the sphenoid was extruded, the patient recovering, was reported many years ago by Baratoux.

In the *treatment* of sphenoidal sinusitis the most important indication is early and free opening so as to permit the removal of necrosed bone, if any exists, and thorough drainage of the cavity. The drill or trocar is introduced in the direction indicated for discovering the anatomical outlet of the cavity, namely, obliquely upward across the middle turbinate body. The distance of the anterior wall from the tip of the nose in the adult varies from three to three and three-fourths inches; the average depth of the sinus is about a half-inch, but the investigations of Onodi and many others

have shown irregularities to be so frequent that these measurements must not be accepted as absolutely reliable. When drainage is once well established and the parts kept aseptic by thorough cleansing, recovery may be expected.

In an elaborate study of the sphenoid by Beaman Douglass attention is directed to the existence in the smaller sphenoidal wings of supplementary cells originally described by Zuckerkandl and Hajek. Their surgical importance is considerable in connection with an inflammation involving either the sphenoidal sinus or the posterior ethmoidal cells. In some cases the main sphenoidal sinus has been found to extend partly or completely into the wing of the bone. In others the sinus in the wing is quite independent and opens by its own passage into a posterior ethmoidal cell or into the *recessus spheno-ethmoidalis*. In still other cases a posterior ethmoid cell is prolonged into the wing of the sphenoid. The relations of these sinuses are described as follows. Above a mere shell of bone separates them from the optic nerve and chiasm and the brain itself. The nasal fossa and the anterior part of the great sphenoidal sinus form their floor. In front lie the posterior ethmoidal cells, while along the outer wall runs the optic nerve, and if the sinus is of large size the carotid artery and the Vidian nerve are found in close proximity. The wall of the orbit may be formed in part by that of the sinus. Obviously distention of the sinus by pus or absorption of its contents creates disturbance in contiguous structures while the risk of damage to the latter in operating is a serious possibility. The existence of this anomaly thus adds not a little to the difficulty of diagnosis and the complications of operative interference. Yet it is claimed that in some cases it may be easier to enter the sphenoidal sinus by cutting away the posterior ethmoidal cells and through the smaller wing than by the route usually followed in the vicinity of its normal opening.

The plan of gaining access to the sphenoidal by way of the maxillary sinus was first suggested by Jansen. He especially advises it in those cases of sinusitis with cerebral complication, in which a rapid and thorough operation must be done, also in cases in which an antral empyema coexists, as well as in those in which the maxillary sinus is not involved, but the nasal route cannot be followed owing to atresia or deformity of the nasal fossæ. The proportion of cases in which the sphenoid cannot be reached through the nasal

passages, if necessary after a preliminary removal of obstructions must be extremely small.

The particular method of opening the sinus is less important than that the aperture should be ample and as near as possible to the floor of the cavity. Spiess prefers to puncture the anterior wall by means of a trephine propelled by electricity. Hajek tears down the anterior wall with a hook passed through the sphenoidal orifice, while Grünwald, after having enlarged the opening with a sharp spoon, breaks off portions of the bony wall in a downward direction with his punch forceps. If on exposure of the cavity it seems to be necessary to curette its walls the greatest caution should be observed in the region of its roof, where the thin plate of bone might easily be penetrated with most disastrous results. Free drainage, removal of all diseased tissue, followed by swabbing the cavity with pure carbolic acid and occasional antiseptic irrigations subsequently are said to bring most of these cases to a successful termination in the course of a few weeks. The risk of hemorrhage in opening the sphenoid is much increased by the proximity of the cavernous sinus and of the internal maxillary artery. From the latter a branch passing through the sphenopalatine foramen sends a small twig across the anterior face of the sphenoid to supply the mucous membrane of the nasal septum. In a case reported by Hinkel a very severe hemorrhage occurring on the tenth day is believed to have had its source in the sphenopalatine artery. Several similar cases of bleeding, primary as well as secondary, are on record in which the flow was arrested by the use of a firm tampon. The difficulty of diagnosis and the danger of surgical interference are thus seen to be much greater in the case of the sphenoidal than of the other accessory sinuses.

HYDROPS ANTRI. MUCOCELE AND CYST. POLYPI. FOREIGN BODIES AND NEOPLASMS.

The ancient term *hydrops antri* is deemed inconsistent with modern ideas of pathology. It seems to be quite certain that a serous or muco-serous effusion may take place into a sinus cavity in the congestive stage of an inflammatory process which never advances to suppuration. For such a condition the term *mucocèle* is appropriate. In a very remarkable case recorded by H. Luc the

frontal and maxillary sinuses of the same side were affected by mucocoele without discoverable cause, the disease being cured by the usual operation performed for empyema of these cavities. He refers to a similar case reported by Laurens in which the ducts from the affected sinuses were occluded by an enormous osteoma. It is not improbable that a mucoid collection may occur in a sinus more often than is generally supposed, since a non-inflammatory process of this kind is attended by so few subjective symptoms. It is possible that an escape of fluid into the antrum may occur in the course of a general dropsy. But these cases are extremely rare. An accumulation of non-purulent fluid in a sinus cavity is in many cases properly called a *cyst*, the walls of the sinus forming its boundaries, in consequence of disappearance of its original limiting membrane by distention, rupture and absorption. In cases of long standing this is likely to be the course of events, whether the process has its inception in a lymph space or in the acinus or duct of a gland, or begins as a dentary cyst. Hence an actual cyst wall is seldom seen. It is suspected that some cases of alleged nasal hydrorrhea are of this kind. The antrum of Highmore is the most frequent seat of this phenomenon. When the ostium maxillare becomes blocked from any cause and the secretion causes distention, more or less pain or swelling may call attention to its existence. In time the anterior wall of the sinus becomes so thin that characteristic crepitation on palpation may be detected. In the case referred to in discussing the diagnosis of empyema of the antrum the contrary was true and it was supposed that we had to deal with a solid tumor, until its character was demonstrated by the light test. The quality of the effusion is usually such as to offer no obstacle to transillumination. In a case detailed by Fergusson exploratory puncture showed the nature of a tumor previously supposed to be solid, while Heath refers to a case within his own knowledge in which the upper jaw was removed before the error in diagnosis was discovered. The quantity of fluid varies from a drachm or two to several ounces. It is colorless or faintly straw colored and may be clear or slightly turbid. Cholesterin is usually found in abundance. Occasionally the fluid is quite dark or even greenish and in a case recorded by Maisonneuve it presented a buttery consistency. The researches of W. Adams, followed by Giraldez, seem to show that cysts beginning in the glandular follicles of the mucous membrane may be

single or multiple and may easily escape detection in the ordinary way of tapping the antrum. In general mere evacuation of the fluid effects a cure. If the cysts are very numerous it may be necessary to curette the wall of the antrum and afterward use astringent irrigations. It is wise to open the cavity freely in order that bony septa or foreign bodies may not be overlooked. The inconvenience to the patient resulting from such a course is insignificant, while its advantage over simple aspiration must be apparent.

Polypi may develop in the lining membrane of a sinus and undergo cystic degeneration precisely as they sometimes do in the nasal chambers. Or their presence may excite a profuse watery secretion which escapes by way of the nasal fossæ and is mistaken for a nasal hydrorrhea. Spencer Watson quotes an interesting case of this kind observed by Paget in which the actual condition was demonstrated by post-mortem inspection. Until symptoms due to pressure or distention appear it may be impossible to offer a diagnosis. Watson calls attention to certain extraordinary cases of cyst of the antrum associated with optic neuritis and nerve atrophy. It would seem that some of the cases included by him in this category, in which symptoms of cerebral disturbance were exhibited, might to-day be regarded as instances of escape of cerebrospinal fluid, a condition to be referred to in the chapter on nasal neuroses. Intranasal polyps often coexist and it is by no means unreasonable to suppose that a condition favoring the development of the former may extend to the mucous membrane lining the accessory sinuses. This especially applies to the ethmoid cells, which are almost invariably found in a state of polypoid degeneration in inveterate cases of nasal polyp. Nasal suppuration is not proportionate to the degree of sinus disease. It has several times been my experience to open an antrum or a frontal sinus and find extensive degeneration of its mucous lining with scanty pus accumulation. The discharge is sometimes slightly offensive, a fact perceptible to the patient if his sense of smell is preserved. Heath declares that polypi of the antrum are very vascular, a fact undoubtedly true of malignant disease but less admissible regarding simple gelatinous polypi. In fact excessive hemorrhage from a tumor connected with the nasal passages must always be looked upon as a danger signal. Simple mucous polypi are not very vascular and spontaneous hemorrhage is unusual. A polyp attached within the antrum has been known

to protrude into the adjacent nasal fossa, but as a rule sinus polypi are small and multiple. The proper treatment for a case of this kind is to thoroughly open the sinus and curette every part of the affected mucous membrane.

Foreign bodies are occasionally found in a sinus, especially the maxillary. Missiles from firearms, teeth erupted in the wrong direction or driven into the cavity in attempts at extraction, lost drainage tubes used in treating a sinus empyema are among the most common. In certain countries animal parasites are not infrequently discovered in these cavities, where they often cause extreme disturbance and sometimes extensive destruction of tissue. A diagnosis is difficult unless the larvæ are found in the nasal discharges. A foreign body may be retained a long time without giving any positive indication of its presence. In a case reported by Lohnberg a piece of metal was exposed in the ethmoid cells after removal of a large number of nasal polyps. Twenty years before this patient had lost an eye by explosion of a gun and unquestionably the piece of metal had at that time penetrated the orbital wall and become lodged in the ethmoid region. In a second case the patient was hit on the forehead with a wrench, a fragment of felt being torn from his hat and driven into the frontal sinus. It excited a chronic suppuration for which an operation was undertaken and the foreign body was thus discovered. Heath refers to a case in which a knife blade was lodged in the antrum for forty-two years and was finally expelled from the nostril, and describes another remarkable case in which a gun breech found its way into the throat after having remained twenty-one years in the antrum.

Neoplasms, either benign or malignant, are met with in a sinus, having originated there or having invaded it from adjacent parts. The latter is far more frequent, at least as regards malignant disease. In this situation a benign tumor, although less accessible, is operable as elsewhere, but the question of a malignant tendency or perhaps a mixed character, especially at certain periods of life, has always to be answered. Malignant disease involving the antrum and more rarely the other accessory sinuses has generally been regarded as a desperate condition. It may assume the type of sarcoma or epithelioma and is so insidious and rapid in its development that in most cases it is beyond reach by the time its character is made known. The age and condition of these patients generally preclude extensive

surgical operations, so that many surgeons prefer to attempt destruction of the growth by the actual cautery and escharotics. Malignancy here is no exception to the law applicable to it elsewhere, namely, that it is curable by the knife, provided all of the disease and every infected lymph channel and gland be extirpated. The difficulty is to define accurately the limits of disease. So-called recurrence means a failure to accomplish this end at the original operation. Those who realize what it is to face the agonies of slow death from an eroding cancer may prefer to take the chances of surgery even though most unpromising.

In a series of cases of malignant disease of the nose and accessory sinuses collected by J. S. Gibb are found five of carcinoma and three of sarcoma primary in the antrum or other sinuses. In three of the former death from recurrence took place (Dombrowski, Bolan-2) of one, in which an excision of the upper jaw was done, no subsequent history is given (Bolan), and in the fifth, in which the antrum was curetted through the alveolus, there had been no return after fourteen months (W. C. Phillips). Of the cases of sarcoma two had recurrence and died (R. Levy, S. M. Burnett) and one, a case of osteosarcoma, in which the upper jaw, the turbinates, the palate, the vomer and parts of the ethmoid and malar bone were removed, had no recurrence eight years later. No doubt many cases have not been put on record. In this connection a remarkable case of success with Coley's toxin treatment in a spindle-cell sarcoma of the upper jaw is of interest. An attempt had been made to remove the tumor by an excision of the upper jaw, but failed and the growth rapidly increased in size. A few injections of the toxins of erysipelas and the *bacillus prodigiosus* were made in the tumor and afterward all were made in the abdominal wall. Although the actual condition of the affected parts is not stated, Coley declares that "the patient practically recovered and resumed his occupation." As an evidence of improved nutrition an increase of thirty pounds in weight while under treatment is noted. Some skepticism might be permitted as to the diagnosis in this case, but for the fact that the verdict rests not only on the clinical symptoms but also on microscopical examination by an expert. While much of the testimony regarding the toxins is negative or distinctly unfavorable, their use is certainly justifiable in cases of recurrent sarcoma or in those decided to be inoperable.

From a study of this subject by Schwenn suppuration, fetor, rapid extension and recurrence would seem to be the main characteristics of malignant disease of a sinus. Pain also is almost invariably present and may be intermittent and neuralgic from compression of a nerve trunk or continuous from distention of the walls of the affected cavity. The tendency of malignant disease of the antrum to perforate at several points on the cheek or into the orbit is observed. Perforation may occur in simple empyema but only at one situation and only in case drainage is absolutely cut off. Ocular symptoms are prominent when the anterior ethmoid cells are involved. It is difficult to determine whether displacement of the eyeball, disturbance of the lachrymal apparatus, or other eye symptoms are due to trouble originating within the orbit or in the ethmoid cells, especially when there is no nasal obstruction and no visible tumor in the nasal fossa. In most cases there is more or less obstruction of one nostril and in nearly every case the septum is attacked. Nasal breathing may not be much impeded. On the contrary when the disease springs from the posterior ethmoid cells the growth projects into the nasopharynx and obstructs the passages. In the latter case also the orbit is almost always invaded with involvement first of the sixth and then of the optic nerve and corresponding ocular disturbance. Tumors of the sphenoidal sinus cause a great variety of symptoms, impairment of hearing, of vision, of smell, of taste, trigeminal neuralgia, ill-defined headaches and finally cerebral symptoms. Their growth is usually very rapid, and the success of radical interference is extremely remote.

CHAPTER V.

DISEASES AND DEFORMITIES OF THE NASAL SEPTUM. DEVIATION.
ECCHONDROSIS. EXOSTOSIS. ULCERATION. PERFORATION.
HEMATOMA. ABSCESS. CONGENITAL OCCLUSION OF THE
NARIS. ADHESIONS. COLLAPSE OF THE NOSTRIL.
DISLOCATION OF THE COLUMNAR CARTILAGE.
FRACTURE OF THE NOSE.

DEVIATIONS OF THE SEPTUM.

The etiology of deviated septum has been the subject of much controversy. It is met with very early in life and has been pronounced congenital in certain cases. It is doubtful whether syphilis is a factor in its causation, but many cases exhibit more or less evidence of scrofulous taint. In a certain proportion of cases we succeed in getting a history of traumatism and, when we consider how exposed the nose is to external injury and how much of the time is spent upon this organ in babyhood, we realize that the condition may be induced by frequent repetitions of mild degrees of violence, as well as by a single severe injury.

The attempt has been made to classify deviations of the septum in accordance with the forms they assume, but the variations are so unlimited that a strict classification is not feasible and is clinically valueless.

In general we speak of horizontal, vertical and sigmoid deviations. In the first the long axis of the deformity is antero-posterior, in the second it is at or near a right angle to the floor of the nose, and in the last the septum is seen to bulge into one nostril above and to the opposite side at its lower part, thus assuming a sigmoid or S form. In some cases the bowing of the cartilage is gradual and symmetrical, in others there is a narrow deep furrow on one side and a corresponding sharp prominence on the other, as if the septum in its plastic state had been compressed in its vertical plane, or, as Lennox Browne puts it, "a crumpled partition" exists. The first is by far the most frequent form and the second the rarest.

Sigmoid deviations are quite common and are perhaps the most difficult to deal with. One of the most intractable deformities of the septum is that in which an anterior deflection of the cartilage is associated with a displacement of the bony septum into the opposite naris, constituting what may be called a *horizontal sigmoid* deviation. Opinions differ as to whether excessive height of the palatal arch almost always seen in connection with a deviated septum bears a relation of cause or effect. The concurrence of adenoids with septal deflection and a high narrow hard palate, especially in young subjects who are mouth-breathers, is a matter of common observation. It is probable that the same diathetic state is concerned in the etiology of each of these conditions. The fact that deviations of the septum are seldom seen in early life, with a history of injury, would enforce the theory that most of these cases are due to arrest of palatal development or overgrowth of septal tissue, or both combined. In early fetal life the hard palate is above the level of the Eustachian tubes and gradually descends in process of normal development. The Gothic arched palate must be looked upon as a frequent result of the maldevelopment often associated with adenoids in the rhinopharynx and consequently as one of the causes of septal deformity. Mayo Collier contends that deflections occur at the thinnest and weakest part of the septum, in consequence of relatively increased atmospheric pressure due to rarefaction of air on inspiration, which latter results from some form of obstruction in the nostril. This certainly cannot be regarded as a satisfactory explanation of all varieties of deviation.

In the majority of cases the cartilaginous septum is chiefly affected; no matter how great a bending may exist in the anterior part we find the posterior margin of the vomer maintaining a vertical position. Hence there is always a sacrifice of breathing space, the wider nostril admitting no more air than its narrowest portion allows to pass. The simplest form of deviation is that consisting of a bowing of the cartilage, one side being concave, the other convex, without marked thickening. Associated with the deflection more or less enlargement of the inferior turbinate body opposite the concavity of the septum exists as a result of nature's effort to prevent the admission of an undue volume of air. The hypertrophy, therefore, is a result, not a cause, of the deviation, though the latter may appear to be the case at first glance.

The frequency of deviation is remarkable; an absolutely straight septum is almost unknown. Inspection of a very large number of skulls in various museums has shown that distortion of the bony septum is present in much more than half of the cases examined. It is reasonable to infer that deformities of the cartilage are far more frequent. Associated with the deviation, in a large proportion of cases, there is more or less thickening of the septum, especially at the apex of the bend in the form of ecchondrosis, or hyperchondrosis, and over the vomer, exostosis. A thickening is also particularly observable along the junction of the quadrilateral cartilage with the vomer and the perpendicular plate of the ethmoid. Its preponderance along sutural lines gives credibility to the traumatic theory of causation, an arthritis being excited by a blow or fall which results in piling up of tissue along the lines of articulation. In other cases, however, where there is an absence of thickening, which would seem to be of inflammatory origin, the impression is given that the bending is a result of overgrowth, or hypernutrition, the development of the septum continuing after the bones of the face have undergone consolidation, so that there is insufficient room in the vertical line for its accommodation.

The *symptoms* induced by a deviated septum are those referable chiefly to nasal stenosis. In cases of extreme displacement, there may be some deformity of the external nose, the tip being tilted or twisted from the median line. Not infrequently the symmetry of the nostrils is impaired, or the *columna nasi* may be displaced. The effects of nasal stenosis are displayed, to a considerable degree, in the region immediately behind an obstruction and in the lower air tract as well. In no small proportion of cases laryngeal symptoms are distinctly traceable to a deviated septum, and a condition of congestion in the postnasal space may involve the Eustachian tubes and lead to a train of annoying ear symptoms. Behind the stenosed area, the air being rarefied with each inspiration, a condition of chronic congestion is induced in the mucous membrane which eventually leads to hypernutrition and hyperplasia. In case of complete stenosis, the functions of the nostril are entirely abolished. The impediment to inspiration is still further aggravated by collapse of the nostril on the affected side in consequence of the increased rapidity of the entering current of air, or weakness of the alar muscles. The effect upon the voice of stenosis due to septal deviation

is often very marked; the quality and tone are impaired both from the abolition of the resonating chamber and from the associated catarrhal condition; in consequence, increased phonatory effort is likely to result in voice strain. In addition, we may have developed a train of reflex nerve symptoms, to be elsewhere considered, when the deviation is so exaggerated as to cause pressure upon a turbinate body.

The diagnosis of deviation is not difficult if one takes pains to compare the nostrils and to explore the nasal fossæ by means of a probe, with the finger tip, or, if need be, with a septometer. (See Fig. 10.)

The prognosis under the present method of managing these cases is good so far as the lesion itself is concerned. As regards complicating disorders the outlook will depend in great measure upon the duration of the condition. In nearly every case we shall succeed in giving a certain amount of amelioration, if not complete cure, which will be permanent provided corrective measures are not undertaken too early in life.

The only *treatment* for the condition is surgical. The earliest attempts to correct the deformity consisted in pressure upon the displaced cartilage by means of the finger repeated by the patient himself at short intervals (Quelmalz, 1750). Various plastic operations have been recommended in which the mucous membrane is dissected up and redundant portions of the deflected cartilage excised, the soft parts being subsequently replaced or brought together by means of sutures (Heylen, 1845). More elaborate operations consist in raising the tip of the nose by external incision or by the incision of Rouge, so as to allow free admission to the nasal cavities. Among the early operative resources, for a long time popular, was that known as the method of Blandin; which consisted in the removal of one or more segments of cartilage by means of a punch, no effort being made to save the mucous membrane. This resulted in permanent perforation of the septum. For many years what is known as Adams' operation was practised, in which the septum was seized with forceps and fractured in such a way as to permit its replacement in the middle line (Fig. 47). The broken septum was retained in proper position by ivory plugs which were worn until firm union. The results of this operation have been disappointing for various reasons. In the first place, the shape of the deformity varies so much in differ-

ent cases that no one method is applicable to all. Thickening at the apex or convexity of the deformity is often more important than the deflection itself, and, finally, the deformity tends to recur, since the spring of the cartilage is not fully overcome. In not a few instances simple removal of the overgrowth of tissue on the convex side restores the air current sufficiently so that any attack upon the

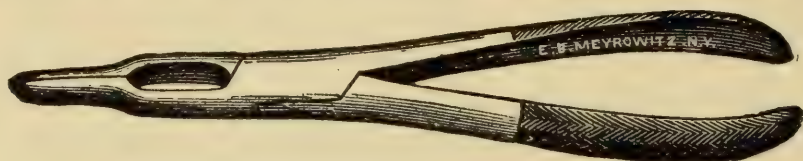


FIG. 47.—Adams' Septal Forceps.

septum beyond this is found to be unnecessary. In many cases removal of the thickened portion with a saw answers every purpose (Bosworth). In others where the thickening does not constitute an abrupt spur or ridge, the drill, or nasal trephine of Holbrook Curtis (Fig. 48) is found to give better satisfaction. The trephine is passed at several levels or the projecting shoulders left above and below its track are smoothed off with rongeur forceps. The

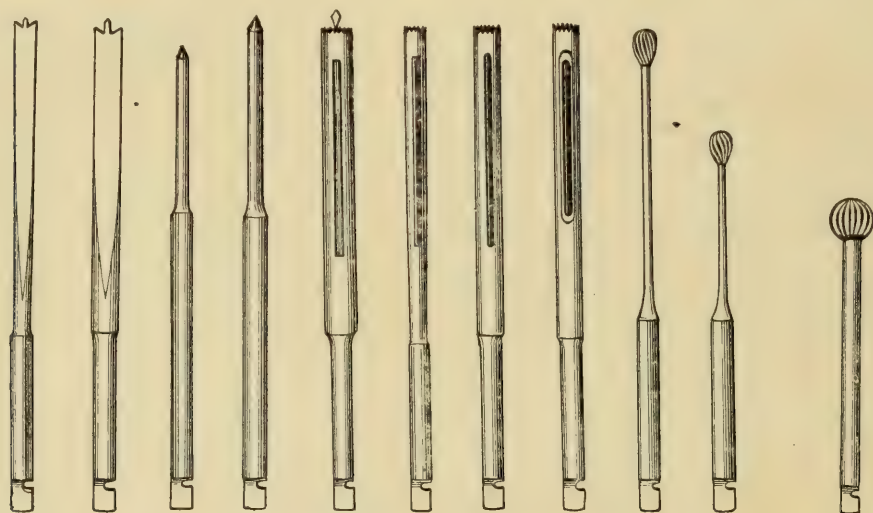


FIG. 48.—Nasal Drills, Trephines and Burrs.

drill and trephine are most conveniently operated by the electro-motor, and the saw also may be used with electric power. It is necessary to reduce a swollen turbinate before attempting to replace a bent septum. All these minor, or preliminary operations are done under cocaine anesthesia. But few would be able to endure the pain involved in fracturing and readjusting the bony septum with-

out a general anesthetic. For cases of simple deflection without thickening the pin operation of Roberts gives good results. In this operation an incision is made along the prominence of the deflection with a bistoury, the parts are then pushed over into position, the edges of the cut overlapping each other, where they are held by means of a long steel pin passed through the columna from the concave side across the line of incision and into the septal tissues above and behind. The head of the pin protrudes from the nostril, or may be concealed in the vestibule, and does not interfere with the breathing; it should remain in place a week or longer until the replaced septal fragments have become consolidated. More than one pin may be required to give proper support, a second being passed directly backward through the dorsum of the nose. It is important that the cartilage should be thoroughly loosened in

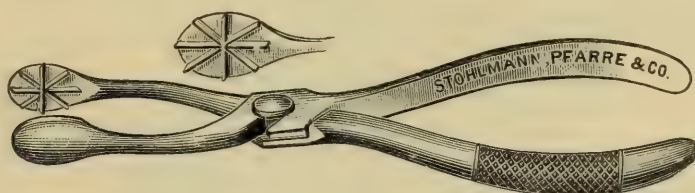


FIG. 49.—Steele's Septum Punch.

order to obviate undue pressure from the shaft of the pin; otherwise there is danger of its cutting its way through the tissues. An obvious advantage of this method, where applicable, is that nasal breathing is not interfered with. Attempts to remedy the deformity by multiple incisions, or by stellate incisions with a forceps like that devised by Steele (Fig. 49) and modified by Sajous and others, have been only moderately successful. Roe prefers to break the septum without lacerating the soft parts, and for this purpose uses a special forceps, one blade of which is larger than the other and fenestrated (Fig. 50). The blades are made of different sizes and are adjustable to a common handle. In Roe's operation the solid or male blade is inserted in the convex side and the ring blade in the opposite nostril. The solid blade fits the ring loosely, and when the instrument is closed other portions of the septum than that immediately compressed are not disturbed. The importance of fracturing the bony septum in most cases is insisted upon, and it is claimed that it may be done with this instrument without any of the risks incident to the twisting and rocking motions necessary with

other septal forceps. In many cases the comminution of the septum accomplished by Roe's forceps does not wholly overcome the redundancy of the tissue which must be provided for by preliminary incisions of the cartilage. These incisions should be made oblique, or beveled, so as to permit the fragments to override each other. Thus the thick ridges formed when the septum has been straightened after cuts at a right angle to its vertical plane are in part avoided. If the cartilage is not excessively redundant these incisions are made from the concave side only to the perichondrium of the convex side, the finger in the latter nostril readily guiding the knife. Usually two incisions, a horizontal and a vertical one, crossing at the point of greatest deformity are required, and a special cartilage knife with a shield which may be used to limit the depth of the cut is recommended. Turbinate hypertrophies, adhesions and so far as possible

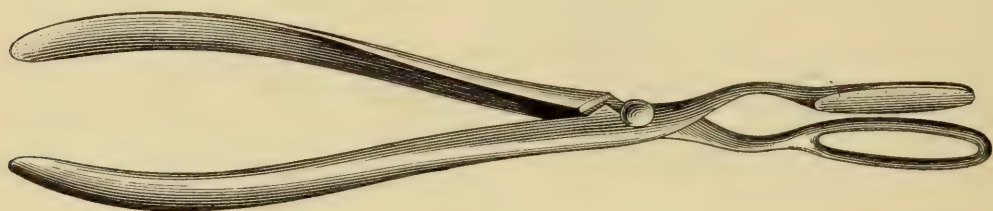


FIG. 50.—Roe's Septum Forceps.

ridges and spurs of the septum should be removed before attempts at straightening are undertaken. A ridge projecting from the intermaxillary bone in the floor of the nose often present in these cases may be broken with the forceps, but not infrequently a saw or chisel is needed if the bone is very dense. For holding the septum in right position a metal plate wound with cotton or gauze to the proper size is preferred to any other mechanical appliance as well as to the tubes in common use. It is left in a place for three or four days, then removed, the parts cleansed with warm borated bichloride solution, 1 to 5,000, and a fresh plug inserted for two days, by which time the septum is usually firm in its corrected position. A tendency to recurrence of deformity may be arrested by the introduction of a non-perforated hard rubber or aluminum tube for a few days. The preliminary work is done with cocaine and suprarenal extract; the actual fracturing under primary chloroform anesthesia.

A mode of operating suggested by E. J. Moure presents several interesting features and is claimed by its promoter to have certain

advantages. Three stages are outlined as applicable to the majority of cases, although the three conditions to be met are not always found. In the first place a ridge of cartilage, or ecchondrosis, at the apex of the deviation is removed with an elliptical ring osteotome (Fig. 51). In the second place the antero-inferior border of the cartilage, which is often luxated into the nostril opposite the convexity of the deviation, is shaved off with a bistoury, after having been button-holed by an incision along its most prominent part. Finally after these wounds have healed, that is, in the course of a month, the deviation itself is attacked. The direction of the incisions and the intranasal splint used for supporting the septal frag-

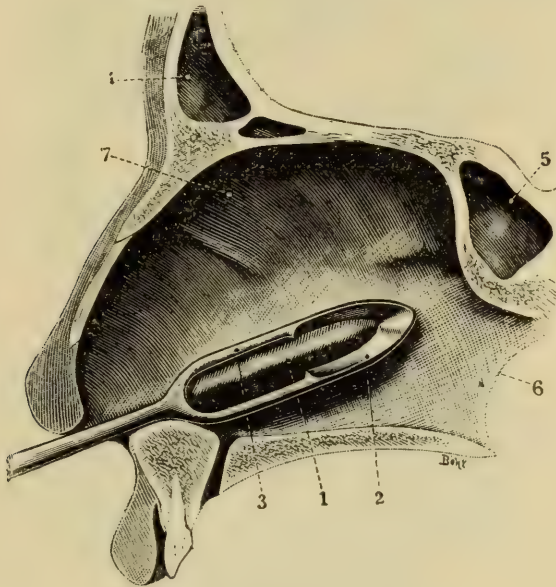


FIG. 51.—Moure's Osteotome.

ments differ from those in other operations. The cuts are made with scissors, almost identical with those of Asch, the first one nearly parallel with the floor of the nose and as close as possible to the inferior attachment of the cartilage (Fig. 52). A second cut is made obliquely upward and as close as possible to the dorsum of the nose, leaving a somewhat narrow bridge of cartilage between the anterior ends and a very wide one between the posterior ends of the incisions. This triangular movable fragment of cartilage is held in front at the tip of the nose by a band of cartilage and behind by the perpendicular plate of the ethmoid and the vomer. A special tube, composed of two parallel blades, the outer one rigid to rest upon the turbinate the inner one malleable, is then introduced. The malleable blade

is then molded against the deviated cartilage, thus correcting the deflection to the desired degree, by means of dilating forceps passed into the tube (Fig. 53). The tubes, which are made in pairs, one for either nostril, are left in situ for at least eight days, a single tube being used only on the convex side in a given case. This method of

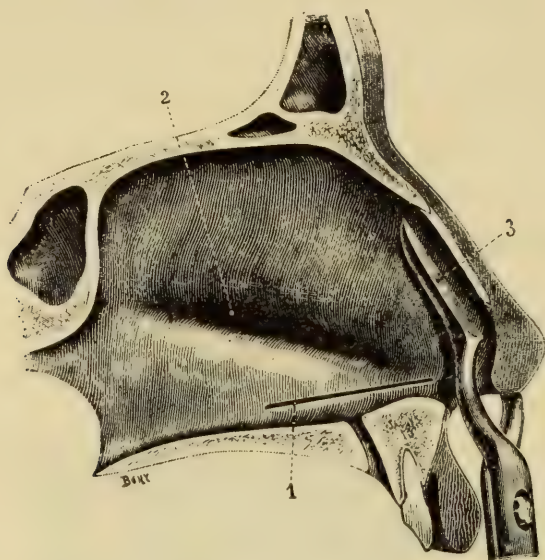


FIG. 52.—Incisions in Moure's Operation.

operating is said to be rapid and not attended by much hemorrhage. Local anesthesia with cocaine is all sufficient, pain, if any, being due to the tube rather than the operation itself. No local treatment is advised, unless there is a good deal of purulent secretion, in which case the nasal fossæ may be douched twice a day with warm boracic acid solution, and the same is applied externally for the relief of

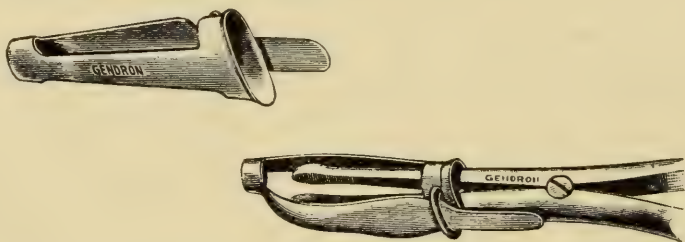


FIG. 53.—Moure's Nasal Tube and Dilating Forceps.

pain. Uniformly good results are claimed for this method of operating at least in adults. It is considered unwise to touch the septum until development is complete, that is, not before the sixteenth year.

In the operation described by Braden Kyle a V-shaped wedge of muco-chondrial tissue is resected antero-posteriorly, the base of the

wedge looking toward the convexity and its apex toward the concavity of the deviation. It may be necessary to remove several of these V-shaped pieces in order to overcome redundancy, especially one on the concave side near the floor of the nose, and even the bony septum may be included (Fig. 54). The so-called "V-shaped sawfile" devised by Fetterolf is preferred for making the excisions (Fig. 55). If the incisions are made at the proper places and in

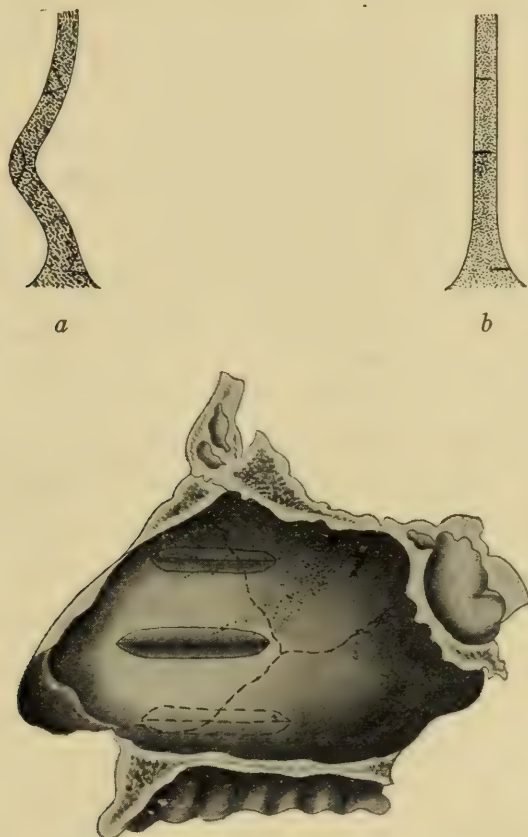


FIG. 54.—Kyle's Operation for Deflected Septum by Removal of V-shaped Segments.

a and *b* show the location of incisions and the position assumed by the septum after the removal of the wedge-shaped pieces. The uppermost of these incisions seems to be on the wrong side of the septum in the diagram and in actual practice it is found impossible to make it along the line indicated.

sufficient number there will be no need of great violence in breaking up resiliency. Malleable metal tubes are preferred for supporting the replaced septum, and may be left in situ many weeks without risk, since they may be perfectly fitted to the position they occupy. There is no danger of perforation provided the blood supply is not interfered with by making the incisions too close together in parallel lines. It is important also to preserve intact the mucous membrane of the septum on the side opposite the cuts.

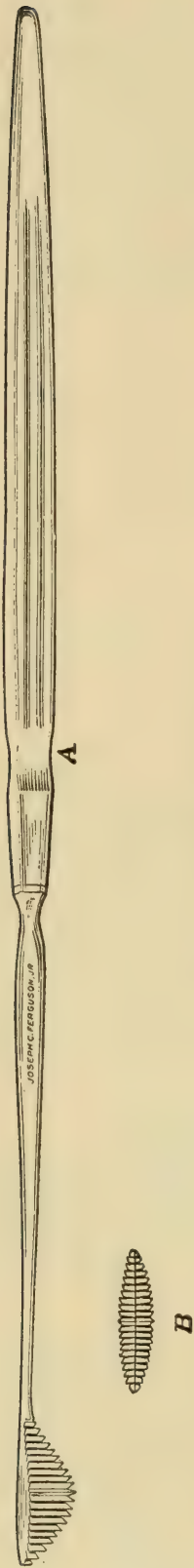


FIG. 55.—Fetterolf's Saw File.

A rare variety of septal deformity consists of a displacement of the whole mass of the partition so that its lower border rests on the floor of one or the other nostril. There is little or no curvature or redundancy. Invariably there is more or less bending of the anterior nasal spine toward the narrow nostril combined with hyperostosis, so that the vestibular floor is converted into a mere fissure. Such a deformity is supposed to be an immediate result of violent traumatism, the associated hyperplasia of bone and cartilage being a natural consequence of the subsequent reparative process. For the condition described the *supralabial operation* of Harrison Allen seems to be admirably adapted. Strange to say, it is very little known, but its merits have recently been forcibly urged by A. A. Bliss, from whose description the following is condensed. The frenum of the upper lip is first divided with a small sharp-pointed bistoury. A chisel with a cutting edge one-fourth to three-eighths of an inch in width is passed into the wound upward to the base of the maxillary crest and then driven with a few blows of the mallet directly backward through the nasal spine as far as the nasopalatine foramen. At once it will be found possible to push the septum over with the finger as far as may be desired, provided the section has been complete. Unless the premaxilla is unusually high, so that the floor of the vestibule is on a higher plane than the floor of the naris in general, the mucous membrane will not be perforated by the chisel. In any case the accident is not of much consequence. The septum is held in its corrected position by means of a rubber tube splint, cold-water dressings are applied externally, and the nares are sprayed every two hours with

an alkaline antiseptic solution. The operation is done under light etherization, and roughnesses may be smoothed down at once or

later under cocaine. The simplicity of this procedure, its effectiveness and the absence of marked reaction commend it in this peculiar form of septal deviation. The patient is kept in bed a day or two and the tube is dispensed with after the second week, making the duration of treatment about the same as in other operations.

The fact has been mentioned that one of the earliest methods resorted to for relieving the subjective symptoms caused by a deviated septum was the formation of a perforation by punching out more or less of the deformed cartilage. Later attempts were made to save the mucous membrane by dissecting it from the cartilage and resecting as much of the latter as might seem desirable. Among the first to do this operation was Ingals, who removes a triangular segment of cartilage from the anterior face of a convex deviation, then detaches the posterior remnant of cartilage from the floor of the nose, forces it into the median line and holds it in position by a tampon of lint charged with iodoform and boric acid. The cartilaginous triangle removed has its apex above and its base below, and its dimensions vary with the degree of deformity. The bony ridge jutting from the floor of the nose which supports the septum is removed with saw, chisel, or trephine. In cutting the cartilage Sajous' knife is used and care is taken not to damage the mucous membrane covering the concavity. If the depression is abrupt or angular it is difficult to avoid perforating, but the flap of mucous membrane formed on the convexity will cover such a lesion. The direction and extent of the primary incision through the mucous membrane must vary with the shape of the deformity. The soft parts are separated from the cartilage by means of a specially designed spud and should be elevated over a considerable area in order to save them from being torn. Shurly quotes Escat as practising a submucous injection of water so as to lift off the membrane covering the concavity and thus protect it from injury while the cartilage is being incised. Anteriorly the soft tissues are quite adherent and must be dissected up, while posteriorly it is easy to raise them with a suitable elevator.

The "window-resection" operation of Krieg (Fig. 56), or what is generally known as "submucous resection," aims to remove the deformed cartilage and bone from between the layers of mucous membrane, a flap being formed on the convex side. In the early experiences there seems to have been some hesitation in attacking

the bone. Nowadays its removal is considered quite as important as that of the cartilage. Difficulty experienced in stripping up the mucous membrane led to the practice of leaving it intact only on the concave side (Boenninghaus). If a wide area is included the inevitable result is incrustation of secretion at the site of operation which often continues indefinitely. Valuable suggestions have been made by many others, especially Killian, whose name is often attached to the operation. Relying upon the assumption that the nasal septum is merely a partition and gives no support to the

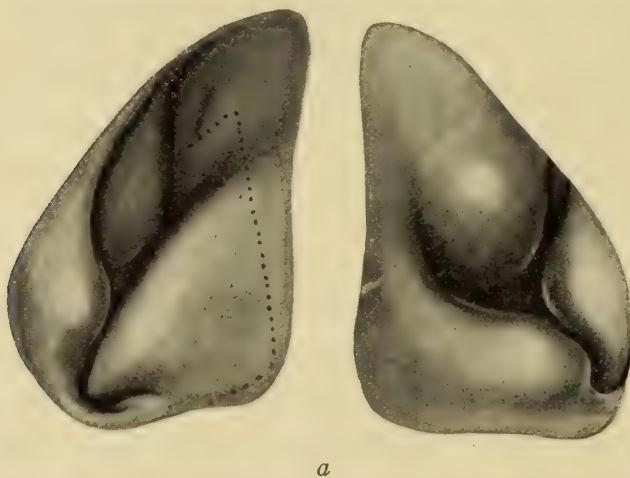


FIG. 56.—Krieg's Operation for Angular Deflection of Septum.

external nose, Otto Freer independently planned an operation differing from that of Krieg in only a few details (Fig. 57). Formerly he was in the habit of fracturing the bone with Roe's comminuting forceps, after having fissured the bone with chisel or trephine. At present he prefers a powerful modification of Grünwald's cutting forceps and removes bone as well as cartilage, in the opinion of some to an extreme degree, yet he claims never to have met with any deformity of the external nose as a result and the muco-perichondrial septum is invariably sufficiently firm. In order to gain more space in the operative field he strongly urges making a "reversed L-incision" through the mucous membrane, an anterior triangular flap being formed with its base toward the tip of the nose. At the conclusion of the operation no intranasal splints are needed, but the nostrils are packed with strips of lint loaded with powdered bismuth subnitrate. This dressing is said to remain aseptic for at least ten days. The objects of the tampon are to prevent secondary hemorrhage and to hold the flaps in place. The

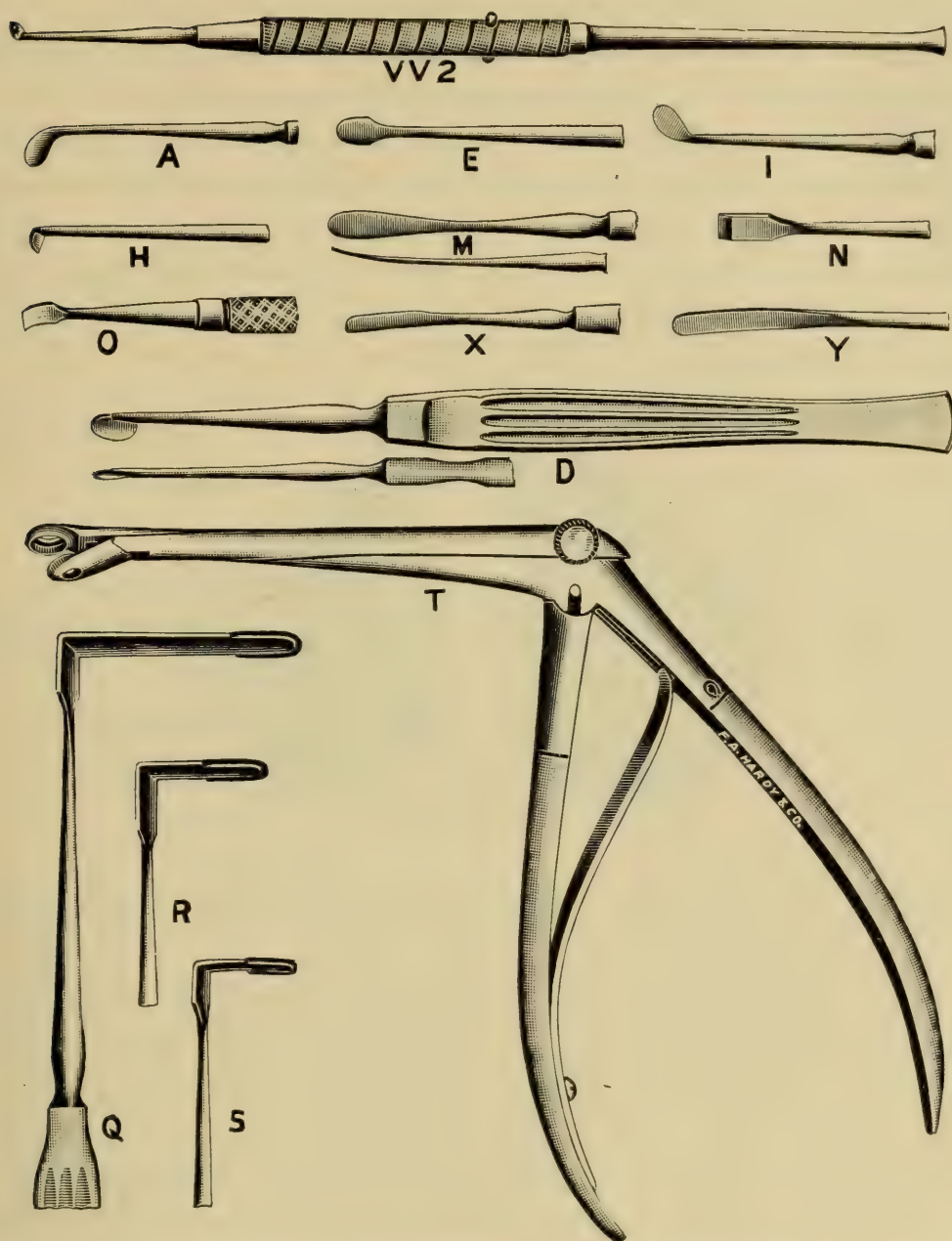


FIG. 57.—Freer's Instruments for Submucous Resection.

V2, hoes; V, dull for lifting edge of cartilage after incision; V2, sharp, for cutting out pieces of denuded cartilage; A, knife, bent on edge, for denudation from right naris of left side of bony ridge on nasal floor; E, knife for splitting periosteum over bony ridge and for dissection; I, round-bladed knife, bent on the flat, for dissecting reversed L flap from below; H, Ingals' cartilage knife; M, broad-bladed elevators, sharp and blunt; N, chisel; O, periosteal rasp, keen-edged, for denuding the ridge and vomer (new); X, short slender elevators, sharp and blunt; Y, long elevators for use in the deeper regions; D, knife for incision outlining the L flap (also small size for children and narrow nostrils); T, Freer-Grünwald reinforced bone forceps; R, S, retractors for nostrils; Q, long retractor for mucous membrane flaps. (Courtesy of Dr. Freer.)

operation is done under local anesthesia with cocaine crystals, which are claimed to give most complete insensibility to pain with a minimum of toxic effects. Moderate chloroform anesthesia must be used in children. In addition adrenalin provides a bloodless operative field. It is said that in some cases new cartilage and bone are regenerated from the preserved perichondrium and periosteum. Experience with the method up to the present time shows that this is not essential, a firm partition is formed and the mucous membrane in course of time resumes its function and becomes moist and free from incrustation.

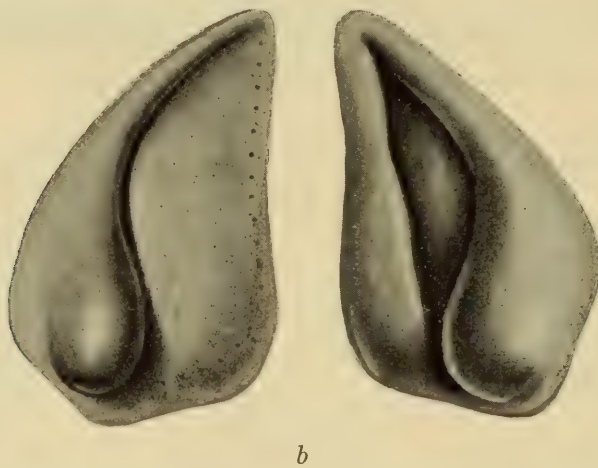


FIG. 58.—“Window-Resection” Operation for Curved Deflection to Right with Lower Border of Septal Cartilage Projecting in Left Naris. (*Krieg.*)

The enthusiasm with which submucous resection of the deviated septum was greeted has rarely been equalled. It was generally adopted by rhinologists, most of whom have something to offer in the line of instruments or operative technic. While it is true that the procedure is simplified by the use of certain instruments, it is not desirable to multiply them excessively. It is not a simple operation, but rather demands unusual fortitude of the patient and exceptional skill and patience from the operator. The objection urged against it that it sacrifices physiological structures is untenable since it cannot be reasonably contended that a strongly deviated septum causing atresia of the nostril and its familiar train of subjective symptoms is performing a normal function. On the contrary, it should be treated like any other diseased structure and remedied by the method which experience proves to give the best functional results. Many who have had very large opportunity for

observation firmly maintain that it meets the indications in every form of deviation. It is undeniably a somewhat tedious procedure, but with increased experience the time of the operation will be shortened and the discomfort of the patient proportionately reduced. In exceptional cases it may be completed in twenty minutes; in some when the mucoperichondrium shows adhesions which must be carefully dissected several hours are consumed. Usually the field is well exposed by a single vertical or slightly oblique incision in front of the deviation, extending from above to the floor of the nose (Killian). It should be carried through the perichondrium on the convex side. The soft parts are then elevated from above downward with sharp or blunt elevators as may be required, risk of tearing the flap being less with the former when carefully used. This is

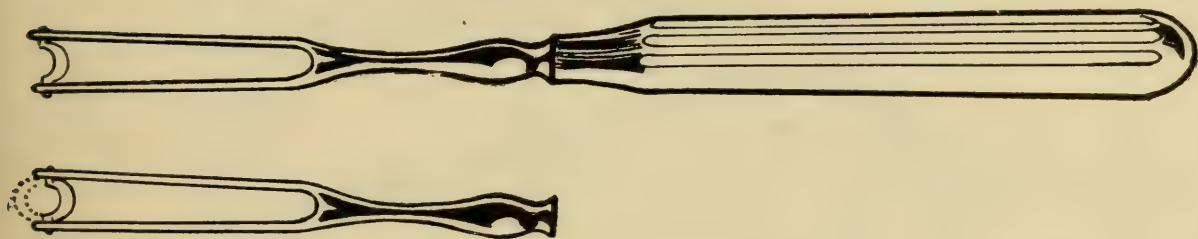


FIG. 59.—Ballenger's Sub-mucous Knife.

done more easily as one proceeds backward, but great care should be taken to get beneath the perichondrium and to avoid perforation of the flap in approaching the angle of the deviation. In extreme deflections it is well not to attempt to go beyond this point until a later stage, or after the anterior part of the cartilage has been taken out of the way.

The next step is division of the cartilage along the line of the primary incision. For this purpose a sharp curette, or preferably the septum knife of Freer or Killian, is used. With an elevator passed through this cut the mucoperichondrium is stripped from the concavity. The cartilage now lies exposed in a sack of mucous membrane and is to be removed in mass with a Ballenger swivel knife (Fig. 59) or piecemeal with a cutting forceps. Obstacles to the former are found in thick and sharply angular septa; with bone the latter only is available. The bone composing the maxillary crest must next be carefully denuded, if concerned in the deformity as it usually is. It is sometimes so dense that a powerful forceps is

needed for its excision (Fig. 60). All distorted cartilage and bone having been removed, it only remains to support the flaps with plugs of sterilized gauze. A tube in one nostril permits nasal breathing and is less uncomfortable. No stitches are required, and after twenty-four hours the tampons may be dispensed with. They keep the mucous surfaces in contact and prevent effusion of blood between them, an occasional annoying accident. A hematoma thus formed may go on to suppuration, when it must be treated as an abscess of the septum, and it sometimes results in perforation. A laceration occurring in the course of the operation is usually covered by the intact membrane of the opposite side. A perforation of moderate dimensions is not of great moment. It is wise to leave a wide strip of cartilage anteriorly to support the external nose and obviate a possible



FIG. 60.—Carter's Septum Forceps.

danger of retraction. The suspicion arises that its occurrence in the rare instances reported may be explained by the existence in the patient of some constitutional taint. Under such conditions no operative interference should be considered. Almost every writer on this topic gives a minute description of his own particular method which he regards as by far the best, but after all a great deal depends upon the ingenuity and skill of the individual operator. The preparation and position of the patient, the mode of inducing anesthesia, the special instrument adapted to a given situation and the dressing of the wound are all open questions to be decided largely by personal preference and experience. The results attained by submucous resection are in the majority of cases almost ideal. Yet it should not be resorted to in children during the formative period of life, in the aged, or in those without the capacity to endure a somewhat long and trying operation.

In hardly any other field is the fact so conspicuous that the perfection of an operative procedure is due not to a single individual but to contributions from many sources. Although these operations

on the nasal septum carry personal titles, which for convenience they are likely to retain, yet in no instance can it be said that they are the exclusive creation of those whose names they bear. Thus the

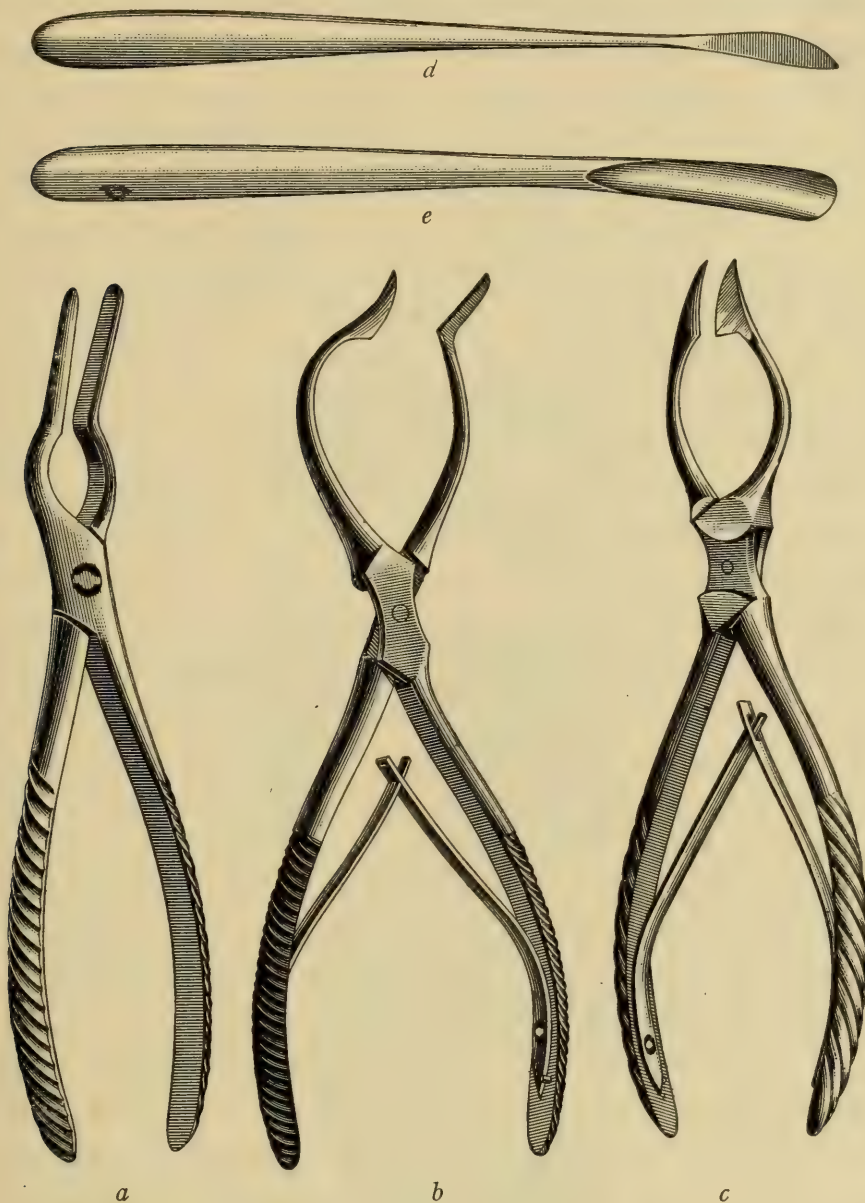


FIG. 61.—Asch's Instruments for Deviated Septum Operation.

a, Compressing forceps; *b*, angular scissors; *c*, straight scissors; *d*, sharp separator; *e*, blunt separator.

Asch operation is really an adaptation of various new and useful technical details to a principle which has long been recognized.

This operation must be done under general anesthesia and with the head of the patient dependent in what is known as Rose's position. Thus the risk of blood or coagula being drawn

into the larynx is abolished (Fig. 61). The special instruments required are first a pair of scissors, after the pattern of a "button-hole" scissors, that portion of the shank between the cutting edge and the joint being curved outward to avoid compressing the columna when the instrument is closed. Second, a curved gouge for breaking up adhesions. Third, a septal forceps, of the Adams' or similar design. Fourth, an intranasal splint to hold the parts in position until repair is complete. Various shapes and materials have been experimented with, tin, cork, Bernays' sponge, soft rubber and hard rubber. A hollow tube, made of the last mentioned material, flattened laterally and with its anterior end larger and shaped to fit the vestibule of the naris gives satisfaction. Some of these vulcanite nasal tubes have numerous perforations into which the mucous membrane is supposed to protrude and thus prevent the tube from slipping. By many a smooth tube is preferred, and if one of correct size has been selected and the spring of the cartilage has been destroyed it will stay in place. It permits nasal breathing and drainage and can be easily kept clean with the least possible disturbance of the wound. Before the operation the nostrils should be thoroughly irrigated with an antiseptic solution. The next step is to introduce a finger into the stenosed naris in order to learn the precise shape of the deformity and whether adhesions are present. The latter may be broken down with the finger or with the gouge. One blade of the scissors, which is blunt and dull, is passed into the contracted nostril, the other, which is sharp, into the wide nostril, and the cartilage is divided through its whole thickness at its point of greatest deviation on a line nearly parallel with the floor of the nose. A second cut is then made across the middle of the former and as nearly as possible at a right angle to it. Thus the cartilage is divided into four triangular segments nearly uniform in size. These segments are then broken at their bases by twisting them vigorously with the septal forceps. As a matter of fact they are not actually broken but are merely released from their bony attachments. This step of the operation demands the exercise of force, since success depends upon its thoroughness. A supporting tube should be selected as large as the nostril will admit and retain without excessive pressure, a matter which it is well to determine beforehand. It is best to proceed deliberately and control the bleeding if possible between the stages of the operation. In rare cases the tube and even

a tampon must be inserted before the hemorrhage can be checked. The patient should be kept quiet for a day or two and the parts gently irrigated with a warm boric acid solution every twelve hours without moving the tube. The occurrence of much pain, marked swelling of the external parts, or decided elevation of temperature

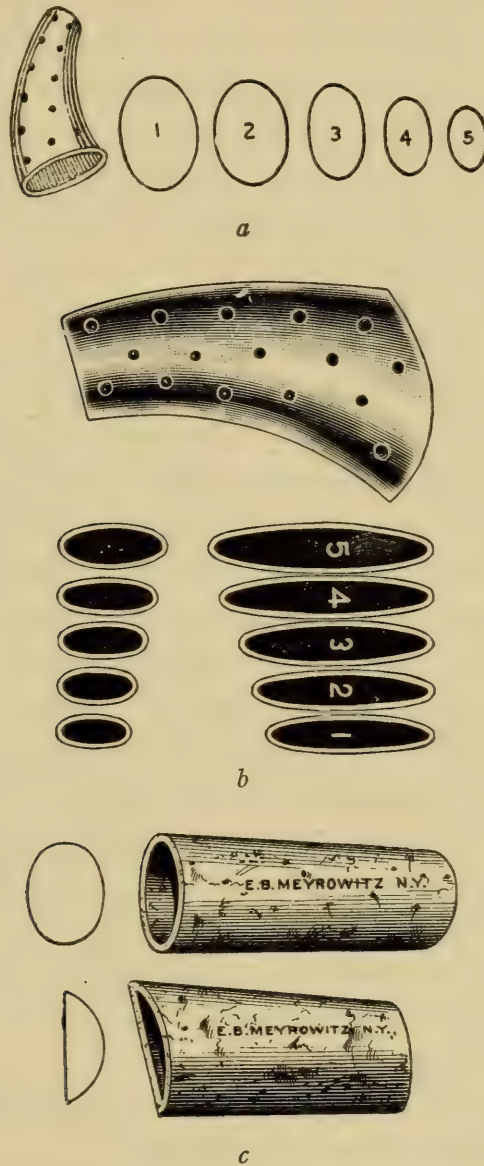


FIG. 62.—Nasal Tubes. *a*, Asch's hard rubber; *b*, Kyle's malleable; *c*, cork.

are indications for withdrawal of the tube and possible substitution of a smaller size. The secret of success in this, as in all operations for deviation, lies in destroying the resiliency of the cartilage. The intranasal tube should be worn at least for two weeks and, in extreme cases, even longer and should be large enough to fill the nostril

without producing painful pressure (Fig. 62). It should be left undisturbed for three or four days, the nostril being cleansed through it by means of douches or coarse spray of alkaline solution. The tube may be easily removed after thoroughly washing the nostril with an alkaline solution and spraying with albolene, and its replacement is painless under cocaine. Unless some special indication arises it is desirable to avoid handling the parts more than is absolutely necessary to keep them clean.

The bleeding during these operations for deviation of the septum is frequently considerable but is usually arrested by the pressure of the tube with the addition of a plug on the opposite side if necessary. As a rule, a tube is placed only in the convex side. An accident which sometimes happens is annoying but not a source of great discomfort, namely, the occurrence of necrosis along the line of incision. My personal preference for making the division of the cartilage is a sharp-pointed curved bistoury which can be more precisely controlled than the scissors, the incisions being made along the lines of greatest deviation and exactly to the desired extent. A septum knife, devised especially for this purpose, is thought by some to be more convenient. One of the best methods of checking bleeding when not excessive is the introduction of pledgets of absorbent cotton soaked in hot water, or adrenal extract.

As a preliminary it is customary to cleanse the nasal fossæ thoroughly with a normal salt or a saturated boric acid solution. Immediately after the operation the parts frequently look unpromising in consequence of thickening of the cartilage from overlapping fragments. Not infrequently we find projecting from the floor of the nose a spur or ridge from the intermaxillary bone which may finally require removal by means of a saw, chisel, or trephine. Nevertheless, it is well not to be in too much of a hurry to attack these thickenings and irregularities since it is remarkable to what extent their absorption is accomplished.

It is very obvious that repair is retarded and the patient is subjected to needless discomfort by too much meddling with the parts after operation. It is impossible to keep these wounds absolutely aseptic and the effort to do so by assiduous cleansing with powerful antiseptics is to say the least unwise. While evidence of the bactericidal power of nasal mucus is not conclusive this fluid does not appear to be a good medium for germ growth, and it is certainly a

clinical fact that wounds of the intranasal structures do uniformly well, provided they are not subjected to extraordinary irritation or the original violence was not excessive. As a rule, gentle cleansing once in twenty-four hours with a simple detergent solution, Seiler's or Dobell's, will be enough to prevent accumulation and decomposition of secretion and will give nature a fair chance.

An excellent method of treating certain forms of simple deviation of the cartilaginous septum without thickening was suggested at about the same time by Watson and Gleason, of Philadelphia, their methods differing only in certain unimportant details. The operation of the latter consists of forming a U-shaped flap of the whole thickness of the cartilage by inserting a saw at the lower limit of the deflection and sawing first obliquely and then directly upward as far as necessary to include all of the deformity, the arms of the U being extended, if need be, by means of a blunt bistoury; in the case of the anterior arm the bistoury is passed on the convex side, and of the posterior arm on the concave side, of the septum. In this way the lines of incision may be prolonged to any desired extent. The flap should be made large enough to completely include the deformity, and is forcibly pushed over to the concave side so as to destroy the spring at its attachment above as completely as possible. Thus the pendulous U is retained by the margins of the incision. The chief advantage of this mode of overcoming the deformity is that there is seldom necessity of intranasal support. The disadvantage is that a considerable amount of irregularity is necessarily left and it occasionally happens that slight perforations may exist at some part of the wound. With this, as with other modes of operating, it is well to postpone measures for correcting irregularities for a considerable time in order to allow the parts to mold themselves.

In Watson's method a similar incision is made upward at the crest of the deviation without going through the mucous membrane on the concave side. The muco-cartilaginous flap thus formed is forced over to the wider nostril, where it is held by its beveled edges. This provides for a horizontal deviation. If a vertical deflection coexists a wedge-shaped piece of the cartilage, large enough to dispose of the redundancy, is excised.

These operations may be done under cocaine. General anesthesia is indispensable when the forceps is to be used in fracturing the

osseous septum. Great care should be exercised in handling the bony septum, especially its upper portion. The magnitude of septal operations must not be underestimated, and the general condition of the patient should be considered. In certain physical states the loss of blood and the shock to the nerve centers from the intranasal traumatism are elements of grave danger. Interference should by all means be postponed until the conditions, local and systemic, are restored to a desirable standard. There is reason to believe that the disasters which have been chronicled as sequels of these operations, but by no means peculiar to them, such as hemorrhage, suppurative sinusitis and even sepsis, are referable to neglect of careful scrutiny of the patient's condition. It is often a difficult matter to decide what is the best operation in a given case. In a large majority the Asch operation will give a satisfactory result, at least when the bony septum is exempt from deformity. Owing to the warnings given by Emil Mayer and by Asch himself, attempts to fracture the bone with the forceps are regarded as dangerous. In a case reported by Robert Levy fatal sepsis occurred and Freer refers to a case in which suppuration of the sphenoidal sinus followed the operation. Such accidents as these, and fracture of the turbinates, as in the experience of Stucky, would seem to be fairly explained by some error in technic or some obscure morbid state in the individual operated upon. The violence required even to fracture the bony septum is in no degree comparable with that inflicted in many traumatisms with no untoward results beyond merely local damage. Hemorrhage in the Asch operation with the head dependent is naturally more free than when the patient is erect, but has been somewhat reduced since it became the custom to use a thorough preliminary application of adrenalin. The objection offered to the Asch tube that it is too much curved is overcome in part by Mayer's modification and completely by that suggested by McKernon, in which the lower border of the tube is straight, and in addition the last has its upper anterior border rounded so as to fit into the hollow of the nasal vestibule without producing irritation. Moreover, it has the advantage of not being perforated. Most of the tubes in common use are too small at their distal end to give enough support to a deflection extending far back in the naris. All tubes made of hard rubber or other inflexible material are unsatisfactory for the reason that they cannot be molded to the nostril. The

latter objection is obviated in the malleable tubes used by Kyle and others. The cork splint of Berens and the compressed cotton tampon (Bernays' sponge) of Simpson, either of which may be readily shaped to suit the case, deserve further trial. The former is cut as desired at the time of operation and is made aseptic by being coated with iodoform collodion. A thin plate of vulcanite has been added by Chappell to the septal surface of the latter, which makes the splint firmer and prevents adhesion of the cotton fibers. If the cotton swells excessively it is a simple matter with a broad-bladed forceps to extract a layer or two from the middle of the splint. A plan proposed by J. G. Roberts is to fasten plates of sheet paraffin, or dental wax, to the surfaces of the Simpson splint by means of aristol-collodion. Thus the splint is introduced and withdrawn with equal ease and while in place the soft paraffin molds itself in a measure to the surfaces with which it is in contact.

One of the most annoying complications of a deflected septum is a disfigurement of the external nose caused by an abrupt bend at the junction of the cartilage with the nasal bones. It is most common in traumatic cases and frequently one or the other nasal bone is depressed. It is impossible to correct the deformity until the bone has been restored to its normal place. This may sometimes be done with a Sinexon's nasal dilator, or with a powerful forceps, like that devised by Walsham, one blade of which is to be applied within and the other outside the nostril. In some cases there is a good deal of thickening at the prominence of the angle, a result of the original injury, which may be shaved down by a guarded electric burr introduced through the nostril, the skin having been first dissected from the hard parts. Or it may be more comfortably removed by external incision, provided the patient is willing to wear the trifling scar that may follow such a wound. In most cases cosmetic effects are considered less important than restoration of breathing space, yet by the exercise of a little care and ingenuity much may be done to remedy these unsightly distortions.

The relation of a V-shaped or Gothic arch of the palate to deflections of the septum, the subject of instructive study by Dean, Mosher and others, is of great importance. Correction of the oral deformity, especially early in life, by widening the dental arch depresses the floor of the nose, expands the nasal cavities and gives space for restitution of a bent septum without sacrifice of tissue.

ECCHONDROSIS AND EXOSTOSIS OF THE SEPTUM.

Ridges or spurs of the nasal septum may consist of cartilage or of bone. In the former case they are called *ecchondroses*, in the latter *exostoses*. They may exist quite independently of deflection of the septum. Exostoses are met with generally far back in the region of the vomer, although it is not unusual to see indications of ossification in anterior ecchondroses of long standing, especially those near the floor of the nose, or a septal ridge may consist of cartilage in front and behind of bone. The possible admixture of osseous tissue has an important bearing on the selection of a mode of correcting these



FIG. 63.—Ecchondrosis of Septum Embedded in Right Inferior Turbinate, with Deep Groove on Opposite Side. (*Krieg.*)

deformities. A pure ecchondrosis, situated well forward, may be readily removed with a bistoury. A long antero-posterior ridge should be attacked with a saw, since bony tissue offers too great resistance to a knife blade.

The varieties of shape assumed by these deformities are almost without limit. Usually they are very irregular; rarely they are symmetrical. Most frequently, perhaps, their lower surface is more or less horizontal, while above they shade off gradually into the septum (Fig. 63 and 64).

The diagnosis of an ecchondrosis is free from difficulty if both nostrils be carefully inspected. A septal protuberance is seen in one nostril without proportionate depression of the opposite side of the septum. The tumor is hard, insensitive, and covered by mucous membrane unaltered or tense and thin. At the apex of the spur the

membrane may be eroded. Exostosis of the septum is less easily detected, frequently being concealed by an anterior turbinate enlargement or a deviation of the cartilage. The use of cocaine and the nasal probe may be essential to its discovery. A septal exostosis rarely impedes breathing, but it is believed to be a prominent factor in many obstinate derangements in the postnasal region and in the lower air track. It must offer more or less obstruction to nasal drainage and be a source of irritation by impinging upon or becoming adherent to a turbinate body. It is often pyramidal or almost conical in shape. It occurs only in adults, a fact which, taken in conjunction with its situation on a part of the septum supposed to be

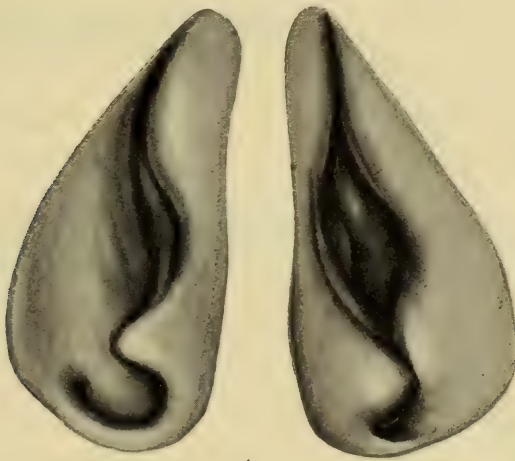


FIG. 64.—Bilateral Ecchondrosis of Septum. (*Krieg.*)

protected from injury, excludes a traumatic theory of etiology. In fact, it seems impossible to explain the origin of these singular deformities.

By far the best instrument for removing these overgrowths is the nasal saw. The ring-knife or "spoke-shave" is much inferior especially in dealing with dense bone. A long thin-bladed saw with teeth set and cutting from behind forward has given me the most satisfaction. It makes very little difference whether the handle be straight or angular, as one may readily become accustomed to either (Fig. 65). It is well to make a preliminary cut through the mucous membrane from below upward in order to obviate the danger of stripping up the soft parts. The excision of the mass itself is most conveniently made from above downward. The saw should be applied at an angle until the soft parts are cut through, when it may

be brought to a vertical position and the section completed, the object being to prevent slipping of the instrument and consequent incomplete removal of the redundant tissue. Under cocaine and adrenal extract the operation is painless and almost bloodless. In exceptional cases each of these agents may fail to produce its legitimate effect, owing usually to individual idiosyncrasy. In the opinion of many, secondary hemorrhages have been more frequent and serious since their introduction, and firm plugging of the nostril is therefore

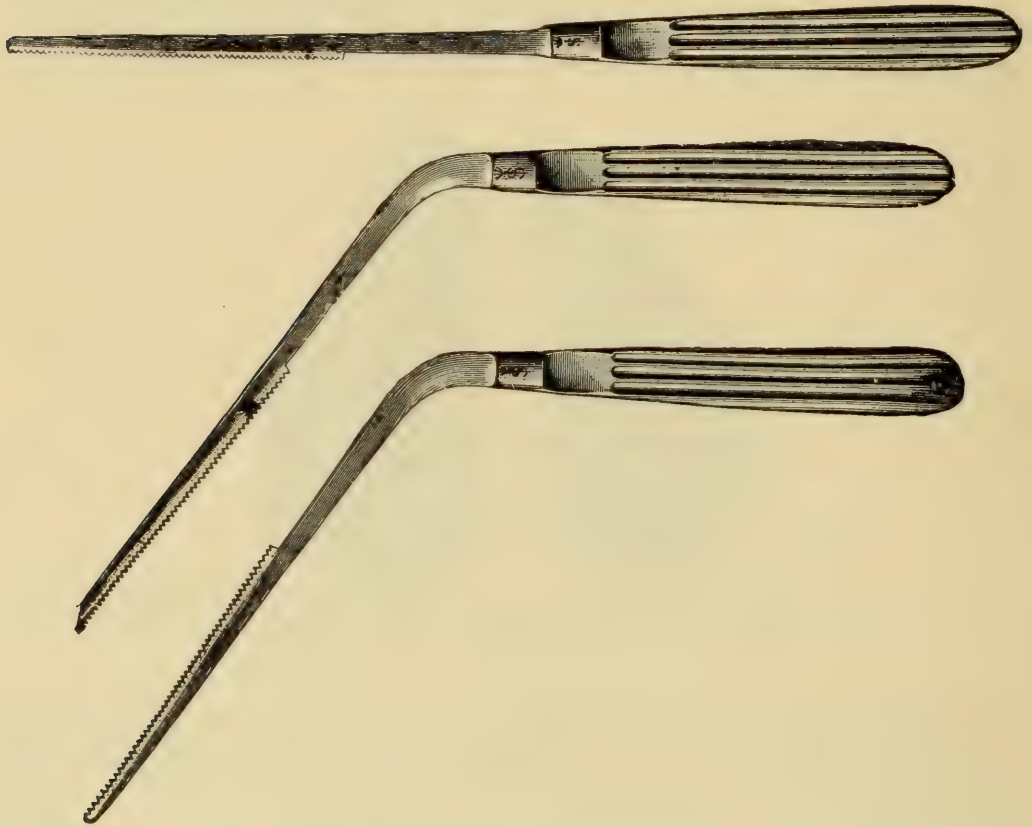


FIG. 65.—Bosworth's Nasal Saws.

advised by some in all these cases. My own feeling is strongly averse to the routine use of the intranasal plug, and my experience has been to be called upon to apply it quite as frequently before the cocaine-suprarenal era as since the use of these drugs became general. Fifteen or twenty minutes after the conclusion of the operation, when all oozing has ceased, both nostrils should be sprayed freely with the suprarenal solution, followed by mentholized albolene. The patient should be cautioned to keep quiet, avoiding physical exercise and mental excitement for the succeeding twenty-four hours, and the

necessity of a nasal plug will seldom arise. The after-treatment is limited to keeping the parts clean and to preventing the formation of adhesion. The latter is accomplished by gently passing a probe between the opposed surfaces or a hard-rubber nasal bougie may be introduced every second or third day. In a spacious nostril and a tractable patient it is an advantage to save the membrane by a sub-mucous operation as for deviation.

The treatment of septal spurs by electrolysis has many advocates. There are two methods of applying it, one called the unipolar and the other the bipolar system. The latter is more generally practised. The source of electricity is a thirty-cell galvanic battery, or preferably the Edison current, of 110 volts, modified by a suitable controller. A strength of from fifteen to forty milliamperes is required. The needles are of steel, or gold-plated, in an adjustable handle. The former material is recommended by Moure and others, but a steel needle at the positive pole oxidizes and must be renewed at each sitting. Iridoplatinum needles are free from this objection and being indestructible may be fixed in a permanent handle (W. E. Casselberry). The pain of the operation is very slight under cocaine, and there seems to be no doubt that cartilaginous spurs may be dissipated by this method. The energy and duration of the current should not be excessive for fear of perforation of the septum, an accident which is avoided by suspending the application the moment a mottling of the mucous membrane of the opposite side appears. The action of electrolysis is sorbefacient, that of the electric cautery is destructive. Yet in reading the histories of reported cases of so-called electrolysis one cannot escape the suspicion that many of them belong in the latter category. We read of a slough separating at the end of a week followed by a granulating surface with pronounced loss of substance. Surely this is not electrolysis! Many authorities vigorously denounce the use of the galvano-cautery on the septum. My own experience convinces me of its safety and efficiency in ecchondroses of moderate dimensions. Much of the prejudice against it is founded upon its improper use in unsuitable cases. Electrical methods at best are inferior to cutting and are permissible only in timorous patients or in those to whom a loss of blood might be detrimental. Any method involving a wide sacrifice of mucous membrane is objectionable. In extensive deformities flap or plastic operations are preferred.

ULCERATION OF THE SEPTUM. PERFORATION.
HEMATOMA. ABSCESS.

Ulcers of the septum may occur as a result of mechanical irritation due to special occupations or may be symptomatic conditions attended by local vascular changes. The apex of a deflection is a common site of ulceration owing to the lodgment of secretion which the patient removes with his finger. This is noticed particularly in young people, an abrasion of the septum following a wound due to the habit of picking the nose. Ulcerative processes may also follow acute fevers, typhoid, or specific disease. In the last the process usually begins in the perichondrium or the periosteum and involves the mucous membrane secondarily. In syphilis the bone as well as the cartilage is apt to be affected. This is true of almost no other ulceration occurring in the nose. The situation of the ulcer depends in part upon its cause, but most ulcers are seen about the middle of the cartilaginous septum.

Overtreatment may result from the anxiety of the patient to obtain relief. In most cases simple cleanliness followed by the application of mild astringents is all that is necessary. Exuberant granulations may need to be removed by cauterization or curetting. The formation of scabs should be prevented by the application of an ointment of vaselin containing ten grains to the ounce of boric acid, or a mixture of white precipitate ointment and oxide of zinc ointment in the proportion of one of the former and three of the latter. The last mentioned is particularly useful in specific ulcerations and, of course, in the latter condition we are called upon to adopt at the same time a vigorous constitutional treatment. A probable result of ulceration, especially when it is extensive and deep, is *perforation* of the cartilage, an accident which may not be of serious import, but, on the other hand, may be followed by some inconvenience as well as disfigurement. A perforation situated well forward and having thick edges is affirmed by Myles to cause the greatest annoyance. A theory of etiology held by C. W. Richardson and others is that the destructive process results from lowered vitality and resisting power of the cartilage due to defective innervation. Tuberculous disease is discovered in a considerable proportion of cases of perforation. Its occurrence in workers in mercury, arsenic and other chemicals has long been known, and Toeplitz reports having discovered it in a large number of those employed in an establishment for the manu-

fracture of Paris green. When the perforation involves only the cartilage it is usually of simple origin, although the ravages of syphilis may be, in rare cases, limited to the cartilaginous septum. Often the perforation is traced to an injury which results in the formation of a *hematoma*. In the majority of cases a hematoma undergoes resolution without destruction of tissue; in others suppuration takes place and the tissues break down unless an early outlet is given to the pus. An *abscess* of the septum, if allowed to pursue its own course, almost invariably results in perforation with more or less sinking in of the dorsum of the nose. It is a curious fact that a perforation of considerable size may exist without the knowledge of the patient. It has been my experience to see almost complete loss of the cartilaginous septum after typhoid fever without external deformity or inconvenience. The rapidity of the process and the resulting deformity vary in different cases. At a meeting of the Laryngological Society of London, W. G. Spencer related the case of a boy in whom a hematoma just within the nares followed a fall on the face. There was no suppuration or immediate deformity, but *two years later* the bridge of the nose began to sink and the nasal septum became much thickened and twisted, probably in consequence of chondritis and softening resulting from the injury. There was no history of syphilis. On the other hand, Haviland Hall referred to the case of a woman of sixty in whom a septal abscess destroyed the cartilage and caused marked deformity within three or four weeks. It seems to be the general belief that in young people during the period of development these occurrences produce more deformity than in adults. Perforations are very apt to give more trouble when their long diameter is vertical than when it is horizontal. Frequently a whistling noise is noticed in respiration and there is a tendency to incrustation of secretion at the margins of the opening. It occasionally happens that a perforation results from necrosis along the line of incision after the operation for deviated septum.

The disturbance caused by a perforation of the septum is generally so trifling that active interference is not called for, unless the patient is annoyed by blood-stained secretions or by a whistling sound in breathing. Healing of the margins of a perforation is often retarded by retraction of the mucous membrane, the cartilage thus being exposed. Reflection of the membrane and resection of the protruding cartilage so as to permit union of the apposed mucous surfaces has

been advocated (Goldstein). Several ingenious plans have been proposed for covering the aperture. In one flaps are formed by making curved incisions in front of and behind the perforation on opposite sides of the septum. These bands are raised from the cartilage and slid over the perforation, one being sutured to its posterior and the other to its anterior margin. Thus areas of denuded cartilage appear on opposite sides of the septum in front and behind, while the opening is covered by the mucous flaps (Burton Haseltine). By still another method a flap is dissected from the inferior turbinate from which it is completely detached after it has become firmly united to the margins of the perforation (Chevalier Jackson).

It is important that we should recognize the existence of *abscess* promptly in order to evacuate the pus early by free incision. If the collection of pus is extensive it may be necessary to incise upon both sides, but usually a single incision is sufficient. The important point is to make the cut near the floor of the nose and wide enough to give good drainage. It is well to keep the edges of the cut apart by a bit of iodoform gauze until the suppurative process begins to abate. At first the pus cavity should be thoroughly washed out with peroxid of hydrogen or boric acid solution and the nostrils should be cleansed with an alkaline spray or douche. There is seldom any difficulty in diagnosing an abscess. The tumor which it forms is generally bilateral and symmetrical and is distinctly fluctuating to the finger or the probe.

CONGENITAL OCCLUSION OF THE NARES.

Closely allied to the subjects just considered is that of stenosis of the nares by bony occlusion of congenital nature. Many cases of partial or complete obstruction due to a web of soft tissue or adventitious membrane are on record, but those in which the obstacle is bony are very rare. Of the latter, in nearly every case the condition has been observed in the posterior nasal region. The impediment may consist of an exostosis from almost any part of the bony framework of the nasal fossa or of a plate of bone growing from the floor or outer wall of the cavity. Unless both choanæ are involved the subjective symptoms may be insignificant. Under the latter circumstances a nursing infant might suffer from the effects of malnutri-

tion. On the other hand, a single patulous nostril may carry enough air to conceal the condition until the child reaches an age to observe that but one nostril is doing its duty.

In a case of my own, a girl of eighteen, no discomfort was caused by the anomaly, except slight impairment of hearing on the corresponding side. In this case the obstruction was complete and consisted of an outgrowth from the hard palate. The septum was deflected toward the stenosed side and the turbinate structures in that fossa were almost rudimentary. The sense of smell was less acute than normal. With the electro-trephine a button of bone one-quarter of an inch thick at its lower and one-eighth at its upper margin was removed, evidently from a plate springing from the floor of the nose. The immediate result was restoration of the nasal air tract and after a few weeks manifest improvement in the sense of smell. No impression was made on the hearing and the patient was annoyed as she had not been previously by accumulation of secretion in the affected nostril. In a case of this kind, therefore, the wisdom of interference is doubtful.

The state of things is very different, however, in acquired stenosis from a developing exostosis or in a condition of double atresia. Here the subjective disturbance may be very distressing, or intervention may be imperative for preservation of life. In order to determine the character of an obstruction, whether bony or membranous, it is necessary to explore with the finger in the posterior naris and with a sharp probe from the front. A soft obstruction may be penetrated and destroyed with the galvano-cautery, one of bone must be attacked with the drill or trephine. The tendency to closure by granulation tissue and adhesions is very marked, and in many cases it has been found necessary to use nasal tubes and dilators for a long period in order to preserve the patency of the nostril.

Membranous occlusion may exist at almost any part of the nasal passage as a congenital malformation, or as a result of struma or syphilis. It may be relieved by multiple incisions, or, if very thick, by excision of redundant tissue and the subsequent use of a nasal tube so long as a tendency to contraction persists. Partial atresia of the choana has been found by W. G. Porter in one out of three persons examined. A membranous fold from the septum, the roof of the nose, or the middle turbinate, or perhaps involving all three situations, is thought to be a vestigial remnant of the bucco-nasal membrane. It is usually situated 10 or 15 mm. in front of the choana and sometimes includes a thin plate of bone. It has no clinical importance unless unusually extensive.

INTRANASAL ADHESIONS.

An accident likely to occur after cauterization of the turbinate body or after an operation upon the septum, especially in a narrow nostril, is an adhesion or synechia between the walls of the nasal fossa. Price Brown justly lays great stress upon the fact that in many cases this results from neglect of after-treatment, the absence of pain and discomfort leading the patient to underestimate the importance of attention. A similar condition may result from erosions or ulcerations occurring spontaneously and is frequently seen in the strumous. The adhesions may consist of bone, of cartilage, or of fibrous tissue. It most frequently exists between the middle turbinate and the septum, or the turbinates themselves may unite. An ulcerative process may be instituted by a foreign body or by pressure resulting from a hyperplastic rhinitis. Adhesions obstruct breathing more or less according to their situation and are frequent causes of a variety of reflex disturbances. In many cases a chronic catarrhal naso-pharyngitis or a persistent tinnitus aurium may be the only prominent symptom. When the adhesion is composed of fibrous tissue it may be divided with scissors or with the galvano-cautery knife; when composed of bone or cartilage the redundant tissue must be removed with a saw or drill. In the after-treatment the case should be watched with great care in order to prevent recurrence; and, with this object in view, it is important that a considerable bridge of tissue should be removed. If care in this respect be observed the use of plugs and tampons will be quite unnecessary. On the contrary some consider it safer to insert a tampon of rubber tissue or even absorbent cotton soaked in albolene, which it is claimed may be left in many days without discomfort or danger, in the meantime the passage being cleansed daily with antiseptic sprays. In the course of convalescence it may be necessary to touch exuberant granulations with some astringent solution, chromic acid, zinc, or nitrate of silver. Until complete repair is accomplished the patient is not absolutely secure against reformation of the synechia.

COLLAPSE OF THE NOSTRIL.

In consequence of weakness of the muscular apparatus controlling the nostrils or a maladjustment of the lateral cartilages some indi-

viduals suffer more or less inconvenience from collapse of the *alæ nasi* especially during forced respiration and in sleep. The condition is frequently aggravated by thickening or by distortion of the *columna nasi* or by an *ecchondrosis* of the septum. In the latter case the trouble is restricted to one nostril and chiefly impedes inspiration. The difficulty may be overcome by directing the patient to wear a tube which supports the nostril and reaches just within the vestibule or the so-called nasal dilator, consisting of a pair of pads connected by a U-spring, one pad intended for either nostril. The pad or dilator is worn only at night or for a limited period during the day. At the same time it is claimed that good results are obtained from massage and from electrization of the alar muscles. A septal deformity must be corrected. W. J. Walsham succeeded in supporting a collapsed nostril by the following ingenious operation. A flap of mucous membrane with its base uppermost was dissected from the inner wall of the nasal vestibule. The surface of the depression where the lower lateral cartilage bends was then made raw. The epithelium covering the flap, the width of which was about three-sixteenths of an inch, was then scraped off, the flap rolled upon itself like a bandage and secured in the depression at the border of the cartilage by a stitch of fine fishing-gut passed through the septum into the opposite nostril and back again. The little ball of tissue prevented the ala from caving in during inspiration and the cure of the condition is said to have been permanent. Harke, who has given a good deal of attention to this subject, notes the frequent failure of removal of a posterior obstruction to restore nasal breathing owing to paresis or possible atrophy of the muscles which should dilate the nostril. He favors mechanical support for the weakened structures, and it would seem entirely reasonable to expect results from measures intended to improve muscular tone in other situations.

DISLOCATION OF THE COLUMNAR CARTILAGE.

There is no separate *columnar* cartilage, the name being applied to the reflected portions of the lower lateral cartilages which assist in forming the partition between the nostrils. Obstruction of one or the other nasal vestibule may be caused by distortion of this cartilage or by displacement of the lower border of the cartilage of the septum. The entrance of the naris, or *limen vestibuli*, may be con-

verted into a narrow longitudinal slit, the outer limit of which is a prominent fold on the inner surface of the ala especially described by Roughton. When collapse of the nostril is added to these anomalies of the cartilage the affected side becomes almost useless especially on inspiration. Attempts have been made to remedy the difficulty by divulsion and by section of Roughton's band without success. The wearing of rubber tubing in the nostril, or the use of nasal expanders, or any form of dilatation is merely palliative. These measures give a certain amount of comfort to those who are averse to operative interference. If the columnar cartilage is at fault a V-shaped incision through the mucous membrane permits the cartilage to be exposed and the excess shaved off with a blunt bistoury or scissors. The triangular cartilage is readily reached by a plastic operation or the projecting portion may be cut off *en masse* without regard to saving the mucous membrane. If the area of the latter thus sacrificed is not too extensive the soft tissues are regenerated and the membrane recovers its function. Otherwise more or less scar surface results over which incrustations of secretion may give some annoyance. The best remedy for this is the application of unguents containing ichthyol or carbolic acid. Cocaine should be applied freely and may be injected into the membrane in case it is necessary to cut near the muco-cutaneous junction. No dressing is needed except a pledget of sterilized cotton or gauze to hold the flaps in place after a plastic operation.

FRACTURE OF THE NOSE.

What is called a broken nose is usually a luxation of the septal cartilage. The degree of violence required actually to fracture the nasal bones or the intranasal framework is generally so extreme as to induce grave symptoms of cerebral damage. The precise location and extent of the local lesion may be obscured by swelling, unless the case is seen very soon after receipt of the injury, and the diagnosis and treatment may call for the exercise of the utmost skill and patience. If the nasal bones are simply depressed it is an easy matter to replace them by means of an elevator passed into the nostril and retain them in place with pledgets of iodoform or nosophen gauze. If they are impacted it is often very difficult to raise them, and if the case is complicated by comminution and displacement

of the septum and perhaps by fracture of the maxilla the problem confronting us is much more serious. In the latter case some form of extranasal apparatus is required as well as an intranasal support. Restitution of displaced parts having first been effected, the nostrils are plugged with iodoform gauze, or a rubber hood, or finger-stall is inserted and stuffed with the desired quantity of sterilized cotton. Either of these will check hemorrhage and give adequate support, but the latter is more readily removed. Both of these are objectionable because they compel mouth breathing, and to avoid the discomfort of that condition a hollow tube of rubber, vulcanite, or malleable material, like that used after an operation for deviated septum, may be introduced and around it cotton or gauze is packed as needed. For an external splint layers of gauze impregnated with plaster of Paris, which are moistened and then molded properly and allowed to set, are found satisfactory. A splint made of sheet zinc and lined with felt extending from the tip of the nose to the forehead is recommended by W. H. Daly. This is molded to the nose and held in place by five tails, two at its lower edge which pass around the head under the ears, two from its upper edge across the forehead and above the ears, and a fifth which passes backward over the vertex from its upper margin. The five ends are fastened together at the back of the head. F. C. Cobb advises a firm head-band of steel, to which are attached pads capable of being adjusted to any part of the nose and the pressure of which may be regulated according to necessity. It is prevented from slipping by bands going across the head and under the chin. A rather ingenious splint has been devised by Jesse Hawes for a bad case of fracture in which he was annoyed by an upward tilting of the tip of the nose. It consists of a piece of No. 15 spring brass wire bent in the form of a rectangular letter U, long enough to extend from the middle of the upper lip over the top of the head. The arms of the U are intended to rest on either side of the nose, its lower portion being slightly bent outward so as to avoid pressure on the upper lip. Each arm is bent sharply forward at an angle opposite the supraorbital ridge and a second time in such a way as to carry it backward over the top of the head. The angles of the wire well padded are pressed firmly under the supraorbital ridge where they are held by a broad band of adhesive plaster, completely encircling the head above the eyes. The tip of the nose is then

drawn down by means of silk ligatures passed through the septum and the mucous membrane and cartilage of the alæ and fastened to the transverse part of the splint. Depressed portions of the nose are supported by means of intranasal springs of wire covered with rubber tubing and attached to the horizontal arm of the splint. The elastic property of rubber is utilized in an external support of tubing, especially when lateral displacements exist. Many surgeons discard splints of all kinds, relying wholly upon the natural support given by the arch of the nasal bones. Perfect results are secured provided readjustment of the parts to a normal position has been accurate. In exceptional cases following extraordinary violence or when a tendency to recurrence of deformity is displayed some form of splint is required. Under ordinary circumstances with an Adams' or Asch's septum forceps and by manipulation of the external nose with the fingers a fracture may be reduced with cocaine anesthesia. In children and in complicated cases general anesthesia is a decided advantage. J. Wright reminds us of many curious and some valuable expedients familiar to the ancients, who were evidently acquainted with the objection, which most of us share in modern times, to the prolonged retention of absorbable material in the nasal fossæ. Plugs of cotton or gauze are far inferior to vulcanite or metal tubes. When a broken nose has been neglected and fragments have become consolidated in a false position it is not easy to restore the normal contour of the nose. It is necessary to refracture the nasal bones, and for this purpose Walsham has designed a powerful forceps, one blade to be applied externally and the other internally. This involves more or less contusion of the skin, to obviate which J. O. Roe advises intranasal dissection of the skin from the surface of the bone and applying both blades through the nostril. E. J. Senn advocates exposure of the nasal bones by an incision along the dorsum of the nose and dissection of the soft parts. The bones are then broken with a small chisel, mobilized and shaped by means of a padded elevator introduced through the nostril, and held in place by passing a needle armed with silver wire transversely under the fragments, the ends of the wire then being attached to disks of lead, or preferably cork or other pliable substance. The disks should be well padded with gauze. Intranasal splints of rubber tubing are inserted, the external wound is carefully stitched with fine sutures, and over all a plaster of Paris mask is held

with adhesive strips. The wire is withdrawn in five or six days, the tubes and the plaster mask in fifteen to eighteen days. An ingenious device by W. W. Carter seems to be based on sound mechanical principles and is especially adapted to deformities from old fracture, disease, or maldevelopment. The apparatus consists essentially of a bridge composed of two curved wings hinged together under control of a thumb-screw and padded with rubber where their margins rest on the sides of the nose. A perforated hard rubber splint for each nostril is adjusted, after the parts have been thoroughly mobilized, by means of sutures of No. 14 iron-dyed silk, passed through the perforations in the splint and with a curved needle through the dorsum of the nose. The free ends of the silk are fastened through fenestræ in the external bridge and traction made to lift the dorsum to the desired extent.

In many of these cases the nasal bones are not involved, but the septum is distorted and thickened, the redundant tissues permitting a resort to a series of subcutaneous plastic operations like those described by Roe. A transverse depression of the dorsum below the nasal bones, or a marked divergence from the middle line of the tip of the nose may be thus corrected. In other cases, when the traumatism has been considerable, the train of events comprises the formation of a hematoma of the septum, followed by suppuration, perforation and more or less loss of tissue. Under such circumstances it often happens that some kind of prosthetic device or an external plastic operation is required. In some cases of old fracture followed by saddle-back deformity the plan of making an incision along the dorsum or transversely above the alæ and inserting a plate of metal, gutta-percha, or celluloid has been successful, while in others the foreign body provoked irritation and had to be removed. The subcutaneous injection of paraffin, to be referred to more at length in the chapter on Syphilis, is well adapted to these cases. Moszkowicz, in Gersuny's clinic, uses a mixture of solid and liquid paraffins in such proportion as to give a melting point of from 96.8° to 104° F. More recent investigations by others indicate that this is a dangerously low melting point. Embolus, or displacement of the mass, is possible unless the paraffin be sufficiently solid.

CHAPTER VI.

NASAL POLYPI

The term nasal polyp properly refers to a gelatinous swelling or tumor of the mucous membrane of inflammatory origin. Some authorities use it indiscriminately to include various forms of benign neoplasm. As a matter of fact, a true polyp is in no sense a neoplasm, although for a long time it was wrongly called "myxoma." Attention has been drawn to the erroneous use of the latter term by Hopmann and Chiari, and in this country by Jonathan Wright. In some cases of long standing the proportion of connective tissue is in excess and gives to the mass a considerable density. Recent polyps have a pulpy character and consist in large part of fluid. This feature is so marked that the qualifying adjective "edematous" is used. In some respects a polyp develops like granulation tissue, cellular elements predominating. It grows more vascular, increases in size by its own weight and finally becomes distinctly pedunculated. The formation of cells and fibrous tissue goes on indefinitely, the serous infiltration progresses at the same time, until a mass resembling a new growth is presented. The process described presupposes the existence of inflammation, yet it is rather unusual to see a well-defined polyp develop in the course of an acute attack of rhinitis. As a rule, nasal polypi are multiple and are observed in both nostrils, more frequently in men than in women, possibly in consequence of the relatively greater exposure of the former to the causes which produce inflammation of the nasal mucous membrane. Although there is, perhaps, no special diathesis predisposing to polypoid formation it is not uncommon to find examples of the disease in several members of the same family. Nasal polypi are seldom seen in children; they are essentially a disease of adult life.

The theory of Woakes that nasal polypi are a direct consequence of a "necrosing ethmoiditis" has met with much opposition and would seem to be conclusively refuted by those cases of polyp seen to spring from the surface of the nasal septum, or from the wall of a

sinus, in which there is no suspicion of bone disease. Soon after its announcement Martin, whose histological studies furnished a basis for the theory, declined to accept it, and later Lennox Browne and Spencer Watson asserted that none of the clinical features of necrosis can be discovered in polyp cases. Baumgarten believes that necrosis is a frequent but not invariable accompaniment of ethmoidal suppuration, while Grünwald declares that polyps may be associated with empyema of *any* of the accessory sinuses and not exclusively of the ethmoid cells. Hajek combats the theory of Woakes and maintains that ethmoid disease is merely a late stage of inflammation extending from the surface, the process being favored by the relative thinness of the mucous membrane in the region where polyps are usually found. The osseous fragility mistaken for necrosis may occur as resorption of previously compact bony tissue or as new formation of bone, and necrosis is a result and not a cause of deep seated inflammation. Cordes is of the opinion that polyps may or may not be indicative of sinus disease, that affections of the bone may be either primary or secondary, and that a tendency to recurrence must be accepted as a sign of bone involvement. The evidence that sinus disease is an etiological factor in nasal polypi is far from convincing, although these conditions no doubt often coexist. In this connection the announcement by Lichtwitz and other observers of the discovery in the post-mortem room of many cases of pus in the antrum which gave no sign during life is of interest, and yet it is quite incorrect to assume that every such accumulation of fluid should be regarded as a sinus empyema.

Inflammatory processes in the ethmoid region vary in degree and may be superficial, may affect the medullary substance of the middle turbinate, or may involve the framework of the ethmoid labyrinth. The ease with which the deeper structures are invaded is explained by the direct continuity found to exist between the mucous membrane and the medulla of the bone. The changes in the bone consist of new formation and resorption, thickening and rarefying osteitis, the two processes going on at the same time, one or the other usually being in excess, but neither occurring alone. The periosteum is thickened and crowded with large nucleated cells. The surface of the bone is marked by depressions filled with large cells, many of which are multinucleated. The bone cells are abnormally large and numerous. At points where the process has reached an

advanced stage are found groups of osteoclasts surrounding areas of disintegrating bone undergoing absorption.

The theory of bone origin of polyps has an advocate in Lambert Lack, who defines a nasal polyp as a localized patch of edematous mucous membrane dependent upon subjacent bone disease. Glandular elements are often very pronounced and not infrequently dilatation and cystic formation result from obstruction of a gland duct. In every case of polyp, whether moderate or extensive, examined by this observer bone lesions of the nature of rarefying osteitis and not a true necrosis were found. With the finger under general anesthesia spicules and loose pieces of bone embedded in soft gelatinous mucous membrane may be plainly felt. A probe is likely to pierce the friable tissue and come in contact with the bone, thus possibly giving a false impression of necrosis. In some cases of long standing it is discovered that the turbinate bone has undergone absorption, having been entirely replaced by a mass of pulpy soft tissue. In others more recent the interior of the middle turbinate bone gradually disintegrates and the cell in its anterior end expands and forms a bony cyst sometimes reaching extreme dimensions. The latter process, which has been described in another section, often occurs quite independently of polypoid degeneration in the mucous membrane and indeed the latter may be in a condition of advanced atrophy.

The *symptoms* of nasal polypi, at the outset, are those of acute or chronic rhinitis and usually begin with what the patient himself calls "cold in the head." Instead of a disappearance of the obstruction as usually experienced after recovery from a cold the nasal stenosis is persistent. If one side is affected the patient may not suffer extreme inconvenience; but if both nostrils are involved mouth breathing results with its usual discomfort. Asthenopia or other ocular disturbances, reflex neuralgias, cough and asthma are among the disorders which nasal polypi are known to excite. In well developed cases the patient is conscious of a movement of a pedunculated polyp during nasal respiration. If its pedicle be unusually long the polyp presents itself at the anterior naris and if its attachment becomes excessively attenuated it may be actually blown out in the use of the handkerchief. There is usually a profuse discharge of watery secretion and speech acquires the so-called nasal quality. The sense of smell is impaired or completely lost either from me-

chanical obstruction to the admission of odoriferous particles or from degeneration of the mucous membrane of the olfactory tract with the contained nerve filaments. Accessory sinus disease may result from obstruction to the outlet of a sinus especially in cases complicated by bone involvement, or may itself institute a condition of the mucous membrane predisposing to edema and polypoid development.

On inspection a mucous polyp appears as a bluish, opalescent, semi-transparent tumor frequently crossed by small blood-vessels and bathed in watery fluid with occasional flakes of purulent secretion. On puncture the fluid contents escape and the tumor shrivels up more or less. An *apparent* capacity for absorbing moisture is often noticed by the laity as the symptoms it produces are much

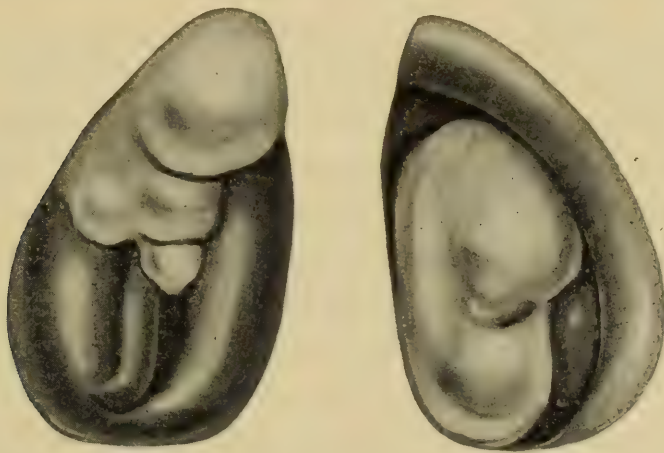


FIG. 66.—Nasal Polypi. (Grünwald.)

aggravated in damp weather. On examining with a probe the fact that it is pedunculated is readily demonstrated. A polyp situated at the posterior naris is more firm than one in the interior of the nasal fossa owing to the normal predominance of fibrous tissue in the former region. This is to some extent true of anterior polyps as a result of irritation to which the latter are subjected. In a large proportion of cases the favorite site of polypi is the margin or free surface of the middle turbinate body. When a sinusitis coexists they are often seen springing from the lips of the ostium maxillare. They rarely arise from the septum although adhesions may take place between a polyp and the septal surface. They may develop to such a degree as to displace the septum or expand the nasal fossa so as to produce considerable facial disfigurement. They are rarely

single and, in some cases, an immense number have been removed; under the latter circumstances the polyps were really compound, several being attached by a common pedicle. They are almost always associated with hyperplastic and later with atrophic changes in the mucous membrane of the turbinate bodies as well as of the septum. They may remain without decided change for a long period, but seldom disappear spontaneously (Fig. 66).

The *prognosis* is good, provided the patient will submit to treatment of a character and for the time necessary to accomplish a cure. When polyps are symptomatic of sinus disease the prognosis is naturally less favorable, and a cure is dependent upon correction of the sinus trouble. The tendency to recurrence is marked unless the underlying inflammatory condition, or bone lesion, is capable of relief.

The *treatment* consists in removal with instruments or destruction of the mass by cauterization. In former times it was a common practice to inject astringents into the substance of the tumor, such as preparations of iron, zinc, or tannic acid and more recently a solution of ethylate of sodium has been recommended by B. W. Richardson as being more effective than the other agents mentioned. A crude method of removing these growths in old times consisted in introducing a polypus forceps, seizing whatever happened to fall between its blades and by a process of twisting and pulling, dragging from the nasal fossa as much tissue as the instrument might grasp. It was a fortunate circumstance if the whole turbinate bone were not removed together with the polypoid mass. It is impossible by this method to operate with precision or safety and in consequence the forceps has been abandoned in favor of the snare except possibly in cases of very small circumscribed growths whose attachment can be clearly defined.

The bleeding excited by avulsion of a nasal polyp usually prohibits any further operative interference for the time being, whereas, with the cold wire snare it is possible to proceed with such deliberation as to make the operation completely bloodless. The number of snares in the market is somewhat appalling. My own preference for ordinary routine work is Sajous' modification of the Jarvis instrument (Fig. 24). In the Sajous snare the loop is held at the distal end of the stylet which permits more exact manipulation than with canulated snares in which the wires are fastened in the handle

of the instrument and are sure to twist on attempting to turn the loop. The capacity of the Sajous snare is limited by its screw thread; in other words the loop cannot be larger than the thread of the screw will exhaust. In using the snare for very large polyps the Jarvis instrument which permits an unlimited expansion of the loop is preferable. This is especially true of polyps which project into the nasal pharynx and where the loop is to be manipulated with the assistance of the finger passed through the mouth behind the velum. In ordinary cases for routine work the straight Sajous snare is thoroughly satisfactory. The loop is introduced in a vertical position between the polyp and the septum, then turned horizontally and crowded over the base of the growth. Care should be taken to hold the instrument firmly after it has once been placed and the thumb-screw when the loop has become engaged may be turned slowly or rapidly at will or as the patient permits. Some prefer the hot wire *écraseur*, but it seems better to cauterize if need be after removal of the polyp. In most cases cauterization is quite unnecessary and the danger of damaging healthy mucous membrane with the heat should not be lightly considered. It is well to cocaine the parts as thoroughly as possible before adjusting the loop, although it is difficult in these cases to get satisfactory anesthesia, and inconvenience from hemorrhage is greatly reduced by the use of suprarenal extract.

Many operators prefer an angular snare in order to preserve an unobstructed operative field. In those cases of nasal polyp in which the turbinate body itself, including the bone, must be in part sacrificed, division of the structures should be very slow and any superfluous weight in the instrument is objectionable. It is an advantage to have as little metal in the snare as may be consistent with strength.

From the standpoint of treatment Lack divides polyp cases into four classes. (1) Those in which the polyps are few and the process in the bone has subsided. Removal with the snare effects a permanent cure. (2) Cases of incipient bone disease with enlargement of the turbinate and edema of the mucous membrane. Here the anterior end of the bone, or as much as may be necessary, is to be removed. (3) Cases more advanced than the preceding in which a few polyps and a limited area of bone disease are present. In addition to the snare, the loop of which should be adjusted as high as possible around the base of the growth, cutting forceps and the ring

knife for curetting are useful, the latter being employed under nitrous oxide anesthesia and good illumination. (4) Cases of extensive bone disease and multiple polyps. A radical operation under a general anesthetic is indicated in this condition. A spoke-shave, or forceps, is used for removing the principal masses, a large ring knife, or Meyer's adenoid curette, is recommended for completing the operation. The scraping should be done cautiously, especially in the region of the cribriform plate, the morbid tissues being identified from time to time by digital examination. Healthy tissue is smooth, firm and resistant to the knife as well as the finger. If the posterior part of the ethmoid is to be attacked the nasopharynx is first tamponed, and in all cases the operation is done with the patient turned well over on the side. On the completion of the operation the nostril is packed with gauze soaked in glycerin-iodoform emulsion, the dressing being changed and the nose irrigated every two or three days. Uniformly good results are claimed for this mode of operating, which presents decided advantages over the tedious nibbling operation in common practice. Some ecchymosis about the eye is a not unusual sequence. A suppurative otitis is not more common after this than other procedures and cerebral complications have never been noted. Febrile reaction, especially frequent in sinus cases, subsides on withdrawal of the packing and a resort to nasal irrigation.

In elderly people and in individuals with organic disease or a weak constitution, intranasal surgery of even moderate severity is often followed by alarming reaction. An operation of the magnitude of that just described involves an intolerable degree of shock and milder methods in repeated sittings must be referred. In fact, the proportion of cases in which such extensive sacrifice of tissue is demanded is extremely small, although there are doubtless inveterate and recurring cases which can be cured in no other way.

The after-treatment of polyp cases is very simple and should be limited to the use of cleansing and antiseptic sprays. Hemorrhage is rarely so free as to require special attention, but occasionally a firm tampon is necessary. The patient should be kept under observation for some time in order to meet the first indications of recurrence and to correct the catarrhal condition invariably present.

CHAPTER VII.

BENIGN TUMORS AND MALIGNANT DISEASE OF THE NASAL FOSSÆ. FOREIGN BODIES. RHINOLITHS. EPISTAXIS.

Fibroma of the nasal fossa is one of the most unusual of neoplasms. In the naso-pharynx it is more frequent owing to the fact that fibrous tissue is more plentiful at the upper and posterior parts of the nasal cavity and in the vault of the pharynx than elsewhere in the upper air tract. The admixture of fibrous tissue in sarcomatous and other tumors is not infrequent; but a pure fibroma is rare (Fig. 67).

The degree of nasal obstruction caused by a fibroma depends upon its location and dimensions. The tumor is usually smooth, round,



FIG. 67.—Section of Nasal Fibroma. (Author's specimen.)

symmetrical and of a darker color than an ordinary polyp, and much denser in structure. It is usually distinctly pedunculated and can hardly be mistaken for a tumor of any other character except possibly an old nasal polyp.

A case of pure fibroma of the nasal fossa came under my observation several years ago. It occurred in a young man of twenty-one who complained of catarrhal symptoms and obstruction of the left nostril. There never had been any hemorrhage, the sense of smell was not impaired and the general health was

excellent. The patient had some cough with moderate expectoration, but there was no suspicion of pulmonary disease. On anterior rhinoscopy a movable tumor could be detected in the left posterior naris attached to the end of the middle turbinate. On posterior rhinoscopy the tumor seemed nearly to fill the left choana. It was smooth, round, symmetrical and darker in color than a gelatinous polyp, but was supposed to be a tumor of that kind containing an unusual proportion of fibrous tissue. It was removed with a cold wire snare without difficulty and with relief of the catarrhal symptoms. Under the microscope there was no trace of myxomatous tissue. The tumor was dense, non-vascular, and near its surface were collections of small round cells suggesting sarcoma, but doubtless of inflammatory origin. The fibrous structure was very marked especially at the center of the tumor.

There is no difficulty in removing a nasal fibroma by the methods used in the treatment of nasal polyps, namely, with the cold wire snare, or if the pedicle is very thick and vascularity is suspected, the cautery loop.

A fibroma of the naso-pharynx is a very different type of neoplasm. Many of the cases on record were undoubtedly mixed in structure and had a semi-malignant character. They are decidedly recurrent and many of the naso-pharyngeal fibromata reported were subjected to repeated operations before their final disappearance. Several of those on record were notably reduced in size by the use of electrolysis. They are extremely vascular and an operation for their removal, when of large size, by the usual surgical procedures is so appalling that electricity offers a desirable substitute for the knife. In many cases the growths are so large as to necessitate division of the soft palate or even excision of the upper jaw in order to give satisfactory access.

Among the rarer neoplasms met with in the nose may be mentioned osteoma, enchondroma, angioma and cystoma.

True *papillomata*, or warty growths, are of somewhat more frequent occurrence (Fig. 68). There seems to be no doubt that some observers have mistaken simple hyperplasia of the mucous membrane for papilloma. Usually they appear anteriorly in the nasal cavity and they seldom attain very great size. They are more or less pedunculated and irregular in contour. They may resemble mucus polypi in color but are less smooth and regular. It may be difficult to establish a diagnosis without the aid of the microscope. Usually removal with the snare or scissors, followed by cauterization of the base, is successful in disposing of them.

A bony tumor, or *osteoma*, in the nasal fossa is extremely rare and is usually unmistakable in character from the resistance it offers to the probe or exploring needle. Generally it is found to invade the nasal cavity from one of the accessory sinuses. It is a most serious lesion and can be reached, as a rule, only by an extensive external operation.

Cartilaginous tumors are still more rare. They present symptoms very similar to those of osteomata and are handled in a similar way. An ecchondrosis, or inflammatory thickening of cartilage, is extremely common and should not be confused with a *chondroma*, or



FIG. 68.—Papilloma of Septum, Left Side. (Grünwald.)

tumor composed of cartilage. The former involves the septum and seldom is seen in the young. A *chondroma* usually occurs early in life, is single, and is not necessarily connected with the septum.

Nasal cysts have been observed in a very small number of cases, not more than three or four such having been recorded. Cystic changes in old nasal polypi are not uncommon. A simple retention cyst may be met with at almost any part of the upper air tract, while dermoid cysts are rarely seen elsewhere than in the nasal cavities. A genuine *cystoma*, or cystic dilatation of the normal lymph-channels, is usually found in adults and may develop at almost any situation. One case of the kind in my experience, in which the tumor occupied the floor of the nose in the left vestibule, was cured by free incision and packing the cavity with sterilized gauze.

In spite of the fact that the Schneiderian membrane is highly vascular, *angiomata* very seldom occur in this locality. Doubtless

many cases reported as such have been confused with other neoplasms richly supplied with blood-vessels. No cause for their development can be discovered, although it probably exists in some condition of malnutrition affecting the walls of the blood-vessels.

The symptoms are such as would result from interference with nasal breathing and drainage added to epistaxis which may be severe or so frequent as to affect the general health.

Pathologically these neoplasms consist primarily in a dilatation of the blood-vessels whose walls, supported by a network of connective tissue, become very much thinned and easily rupture. Angiomata may spring from a turbinate body or from the septum; usually they have been seen in the latter situation near the anterior nares, constituting the so-called "bleeding polyp of the septum."

Their appearance is characteristic. An irregular, elastic tumor of reddish or purplish color, from which hemorrhage is readily excited by rough handling, is seen attached to the mucous membrane by a broad base or a much constricted pedicle. It is of slow growth and there is no danger attending it aside from hemorrhage which may be prevented by the selection of a suitable mode of treatment and the avoidance of violence.

Either the cold-wire or the galvano-cautery snare may be used in its removal. The loop should be adjusted well down upon the base of the tumor and should be tightened very slowly, especially if the cold-wire *écraseur* be employed. Recurrences after thorough extirpation are not usual.

It is obvious that a great deal of confusion exists in the nomenclature of intranasal neoplasms. For example, the term "papilloma" has been erroneously applied by Hopmann and others to papillary hypertrophies. A genuine papilloma has definite histological characteristics which differentiate it positively from hypertrophy, or hyperplasia. Again simple varicosities, or vascular dilations of the blood-vessels of the mucosa, have often been wrongly called "angiomata." In reading the descriptions of many cases of so-called "nasal fibroma" one cannot avoid the conviction that the tumors possessed a mixed character or were actually malignant. Moreover, some of these neoplasms originated in an accessory sinus or in adjacent structures and not in the nares, and hence cannot be properly classified as "nasal" fibromata. Those formidable cases in which occurs "frog-face" deformity from expansion of the nasal

bones, and violent hemorrhages take place, both spontaneously and when attempts at removal of the neoplasm are undertaken, are in this category and belong within the scope of general surgery.

According to Lennox Browne the question of transformation of benign into malignant growth is settled in the affirmative. The testimony offered by one of his alleged cases, in which the patient himself "attributed his trouble to the frequent and long-continued introduction of a Eustachian catheter" is certainly far from acceptable. This distinguished authority asserts that "sarcomatous degeneration is most commonly witnessed" while epitheliomatous transformation is more rare. He cites several cases supposed to be confirmatory. An interesting and curious case was reported by Bayer in 1887. A villiform carcinoma was found implanted upon a base of innocent mucous polypoid tissue, but even in this case there remains a doubt as to which tissue was primary. A case of carcinoma developing from a simple papilloma, under the observation of M. R. Ward, was thought to be proved by microscopic examinations to be a genuine example of transformation.

In a most interesting case of adenocarcinoma reported by F. E. Hopkins, it is supposed that malignant transformation was provoked by violent manipulation, although the evidence is somewhat presumptive. It appears that on three occasions, at intervals of a year each, attempts had been made to remove "myxomatous" tissue by forcibly dragging it out with polypus forceps. Symptoms of an intranasal growth had existed for many years and its benign character was inferred from the form, color and consistence of the neoplasm removed as well as from the fact that but slight hemorrhage followed the operation. No microscopic examination was made at this time. In commenting on this case Jonathan Wright remarks upon the rarity of lesions of the kind and upon the rapidity of their evolution, adenocarcinoma being somewhat slower than pure carcinoma. He has collected twenty authentic cases, discarding those not supported by microscopic testimony, a lack of which applies to more than half of those in Bosworth's list, but including several, like that of Beaman Douglas, of possible extranasal origin.

Whether we accept these unusual instances as authentic, or, with Billroth, look upon the whole matter as a "traditional myth," the occurrence is not so frequent as to deter us from interference in suitable cases.

MALIGNANT DISEASE OF THE NOSE.

Malignant disease may have its origin in the nasal fossa, but frequently begins in adjacent structures and gradually crowds into the cavity of the nose. Carcinoma, presenting in the form of epithelioma, is rather more frequent than sarcoma according to Bosworth's figures, but in the opinion of J. S. Gibb, who adds 70 cases of sarcoma and 48 of carcinoma, "primary carcinoma of the nasal chambers is undoubtedly rare," while sarcoma is believed to be more common than statistics would seem to indicate, many cases remaining unrecognized and more not being reported. The latter is usually of the round-celled variety and may occur at any age. The former is seen seldom before middle life. Men are more prone to the disease than women. The starting point of the disease may be in the antrum, and as the growth progresses tumefaction of the face appears, accompanied by occlusion of the nostril from pressure upon the nasal wall of the antrum, or protrusion of the mass through the ostium maxillare. Pain may not be pronounced until the disease is far advanced, but there is apt to be at an early period a bloody discharge from the affected nostril. Free and even fatal hemorrhage may occur.

In a case of fibrosarcoma reported by the author several years ago the tumor grew in all directions, finally invading the cerebral fossa and causing total blindness. In the meantime the growth had extended to the pharynx and impeded respiration. Previously on several occasions severe hemorrhage had taken place, spontaneously, and when attempts were made to clear the air tract by snaring off portions of the tumor. At length, during a fit of wild delirium consequent upon cerebral irritation, the patient thrust his fingers in his mouth and dragged out a large piece of the growth hanging over the margin of the velum. Immediately there was a fierce gush of blood from the nose and mouth and in a few hours the patient succumbed. It was impossible to determine where the disease began, as it was first seen at a late stage and no autopsy was permitted. However, at a radical operation with removal of the upper jaw, undertaken by Weir several months before at the New York Hospital, it was found that the ethmoidal cells and the sphenoidal sinus were filled with neoplasm the limits of which beyond could not be safely traced.

In view of the uncertainty regarding the implantation of malignant tumors of the nose it is an open question whether all cases of this kind should not be referred to the general surgeon for radical operation. Piecemeal removal with forceps and snare is

a superficial method which permits the base of the neoplasm to pursue its destructive invasion of adjacent parts. By many it is positively discountenanced (A. F. Plicque), while others are of the opinion that although no operation whatever is feasible in carcinoma, sarcoma is best treated by removal through the nose with the cold-wire snare (Bosworth). Of course the latter applies only when the disease is known to be strictly confined to the nasal chamber. In a case of this kind operated upon by Melville Black it was my privilege to watch the course of events several years subsequently. The growth involved the right middle turbinate and was removed with snare and forceps. Its sarcomatous nature was established by repeated microscopic examinations. More than ten years elapsed without sign of recurrence. Several weeks after a severe attack of typhoid fever obstruction of the nostril and nose-bleed led to an examination when unquestionable regrowth of the tumor was found. After some months' delay an external operation was done by B. F. Curtis who removed a large part of the naso-antral wall together with the neoplasm which occupied the middle turbinate region and had invaded the antrum.

Implicit faith in the microscope as a guide in diagnosis is not advisable, at least as applied to sarcoma. A young woman once came to my clinic with stenosis of her right nostril. An extremely vascular tumor extending far back in the nostril was removed and quickly recurred. Microscopic examination pronounced it a sarcoma and all preparations were made to expose and remove the neoplasm by an excision of the upper jaw, when she called attention to a tumor over the crest of her tibia. Under rapidly increasing doses of potassium iodide the periosteal node and the nasal sarcoma (?) disappeared simultaneously. Such experiences should not discredit the microscope nor the examiner. Different sections of the same new growth may present totally different appearances, and it is often impossible to differentiate a small round-celled sarcoma from a syphiloma. They should rather teach us to be cautious in accepting testimony derived from a single source in cases of this kind. When there exists the least doubt as to the nature of a neoplasm a tentative antisyphilitic course of treatment is always indicated.

The difficulty in diagnosis is often vastly augmented, especially in elderly patients, by the concurrence of malignant disease and simple mucous polypi. The presence of the latter may obscure the

case until in the process of clearing out the polyps with the snare we are startled by an alarming hemorrhage from an exceedingly sensitive growth, which proves to be malignant. Fetid discharge, hemorrhage and distortion of the face from intranasal pressure are seldom or never observed in gelatinous polypi and are invariably present earlier or later in malignant disease.

In some cases neighboring bony tissues become affected. If the disease is located in the antrum the orbital plate is pushed up, forcing the eye from its socket, the skin of the face becomes adherent to the anterior wall of the antrum, which finally breaks down, permitting the protrusion of a fungous mass of vascular sensitive tissue. Cases which survive to this stage are most distressing from the disfigurement, the pain and the insupportable fetor attending the profuse ichorous discharge. The glands are seldom implicated. The development of epithelioma is much more insidious and rapid than that of sarcoma and may proceed without much pain or tumefaction until a late stage. Malignant disease may cause death by invasion of the cranial cavity, by exhaustion, hemorrhage, or metastasis, the last mentioned being more frequent in sarcoma. The record of results of operative interference is not encouraging, at least when the disease is so extensive as to require an excision of the upper jaw. According to H. T. Butlin, whose researches on this subject have been most thorough, the chief operative dangers are from exhaustion, blood-poisoning and pulmonary complications. He believes that unless measures to secure a better showing are feasible the operation should be condemned. Recurrence is almost inevitable, and in any case malignant disease of the nose must be regarded as one of the most formidable and intractable with which we have to deal. This discouraging view is in a measure refuted by the brilliant results secured by Abbe in several cases of malignant disease which would ordinarily be regarded as inoperable. In one case in particular the right upper jaw and roof of mouth and part of the roof on the left side were removed, after a tracheotomy and ligation of both external carotids. This patient, a man 63 years old, was exempt from recurrence five and a half years after operation, the effects of which, in part owing to a well-fitting plate, were scarcely perceptible. For details of the major operations the reader is referred to works on general surgery. In most cases we shall be called upon to rely solely on the free and constant use of anodynes.

FOREIGN BODIES IN THE NASAL CHAMBERS.

The introduction of a foreign body into the nose, either intentionally, accidentally, or in the act of vomiting, frequently occurs and may result in considerable disturbance. A one-sided purulent nasal discharge in a child is always suggestive of a foreign body. The objects children select are shoe-buttons, pebbles, or in fact any article small enough to be admitted to the anterior nares.

As a rule, if no attempts have been made to extract the foreign body it is found lodged well forward in the nasal fossa. In many cases it is retained for years and in the meantime the patient is supposed to be suffering from nasal catarrh. Usually a purulent discharge is the only symptom and frequently its character is so acrid as to produce more or less excoriation of the nostril and lip. The pressure of a foreign body may cause erosion of the mucous membrane with which it is in contact and occasionally perforation of the cartilaginous septum results. In the event of laceration of the membrane the discharges show more or less admixture of blood. Syphilis may produce a one-sided nasal discharge but is attended by other symptoms which are confirmatory. Sinus disease generally causes discharge from one nostril but it is rarely observed in children and is seldom accompanied by obstruction to the nasal breathing which is usually a prominent symptom of a foreign body.

A definite diagnosis can be made only by inspection and sometimes by the use of the probe. It is necessary to cleanse the parts thoroughly of secretion and to apply cocaine, and, in young children and in nervous subjects, a general anesthetic may be required. As a rule, foreign bodies are within reach and can be extracted readily by means of a nasal forceps. Sometimes removal may be effected by passing a blunt hook, like a strabismus hook, behind the object. The loop of a cold snare is found to be useful. If the foreign body has slipped or been displaced into the postnasal space it is necessary to push it forward by means of the finger passed through the mouth behind the palate or it may be removed through the mouth. Sternutatories, the use of douches and the Politzer air-bag have been recommended for the removal of foreign bodies. The two latter methods are attended by more or less risk to the ears and, moreover, are less reliable than the nasal forceps. In rare cases in which the foreign body is of such a character as to imbibe moisture and in-

crease in size after its introduction, or in cases in which it has become impacted, it is necessary to do an external operation in order to secure more space for manipulation, or the object may have to be crushed and removed piecemeal.

Many cases in which teeth have been found misplaced in a nasal fossa have been recorded. An interesting example noted by Krieg is that of a girl nineteen years old in whom the right lateral incisor "had lost its way upward" and was seen impinging upon the border of the inferior turbinate. Extraction would of course be indicated provided any subjective disturbance results from the anomaly.

RHINOLITHS.

A nasal calculus usually has a foreign body of some kind as a nucleus. A plug of inspissated mucus, or a coagulum, may furnish a base for the incrustation of salts. The shape of these calculi corresponds closely to the conformation of the nasal fossa. Some of those on record reached a most enormous size.

The causes which induce them are not clear. It would seem probable that some malformation of the nasal passages must be in part responsible for them, possibly in combination with an obscure change in the character of the nasal secretion. They are found to contain the ordinary ingredients of nasal mucus with a large proportion of organic material and, in some cases, a small quantity of iron.

As a rule, the symptoms are those which naturally would be excited by a foreign body. In some of the more remarkable cases on record the disturbances were very profound. Distortion of the nose and hard palate and even perforation of the palate at its junction with the velum, facial paralysis, and ocular disturbances are enumerated. The discharge from the nose is almost always offensive, profuse and unilateral.

The diagnosis is usually free from difficulty and is established by inspection and the use of the probe.

The treatment is similar to that of a foreign body, although a calculus may be too large to be removed entire and must be crushed beforehand. The density of the mass is sometimes so great as to make this by no means easy. A small lithotrite has been found useful for this purpose.

EPISTAXIS.

Nose-bleed may be traumatic, spontaneous or vicarious. Traumatic nose-bleed may result from blows upon the external nose or from injuries to the mucous membrane from the introduction of foreign bodies, from violent blowing or sneezing, or from picking the nose. When the injury is of a serious character fracture of the nasal skeleton may involve the base of the skull and bleeding may arise from the ear as well as the nose, that from the latter being comparatively unimportant. In some cases the blood finds its way forward, but in young subjects or unconscious patients a considerable quantity may flow backward and into the stomach, the persistence of the bleeding being finally betrayed by the occurrence of hematemesis or collapse. In post-operative hemorrhage one knows where to look for the source of the bleeding; otherwise, it is a matter of considerable difficulty to determine precisely its origin.

Spontaneous nose-bleed may be symptomatic of an intranasal neoplasm or it may occur in various constitutional conditions affecting the general circulation. It may be indicative of disease of the blood-vessels or of certain changes in the character of the blood itself which prevent coagulation. It is not uncommon in hemophilia and several members of a family may habitually have nose-bleed.

A sudden spontaneous nose-bleed in persons fifty years of age and upward should always excite suspicion of cardiac or other organic disease. This form of epistaxis has been carefully studied by George Coates, who finds the occurrence preceded by long-continued high arterial pressure and immediately by cardiac failure, either valvular or in the wall of the heart, accompanied by engorgement of the whole venous system. In these cases the indication is to relieve the turgid veins and the arterial pressure. After the capillaries and arterioles have been dilated by agents like nitroglycerine, so-called heart tonics, strychnia and strophanthus, are useful. Plugging the nostril is seldom necessary and is generally futile, because the real difficulty is not in the nose.

A very rare variety of epistaxis associated with multiple telangiectases of the skin and mucous membranes has been reported by William Osler. The angiomas were in various regions, but especially on the face which they much disfigured. In one fatal case

they were found in the mucous membrane of the stomach, as well as in the nose, and the nasal septum was marked by numerous dilated veins. A relationship between telangiectases and hepatic affections is suggested, and obviously local measures, so far as the hemorrhage from the nose is concerned, can have only a palliative and temporary effect.

Vicarious epistaxis has been observed in women whose menses are suppressed and in functional uterine disease. Epistaxis is a common symptom in many exanthemata and fevers and is especially noted as an early symptom in typhoid. It is also a very frequent occurrence in diphtheria and is included among the symptoms of adenoids in the rhinopharynx.



FIG. 69.—Swollen Granular Turbinates a Frequent Source of Epistaxis. (*Krieg.*)

Fatal nose-bleed is an extremely rare accident and is hardly likely to occur except in hemophilia or in an individual already in a condition of extreme systemic depression. When confronted by a case of nose-bleed it is of the first importance to determine the source of the bleeding. It is not at all an unusual experience to meet with cases in which attempts to arrest the bleeding have been made by plugging the nostrils, whereas had the precaution been taken to determine the origin of the bleeding this disagreeable and somewhat dangerous process might have been avoided. In a very large proportion of cases a careful examination discovers that the blood comes from a turgid granular turbinate body, or much more frequently from (Fig. 69) an eroded point on the septal cartilage within a very short distance of the anterior naris and above the floor of the nose. This is referred to by some writers as “Kiesselbach’s

spot," so named from an observer who has drawn especial attention to the small artery in this situation as a source of nasal hemorrhage (Fig. 70). Pressure exerted at that point fortified by the application of some styptic hardly ever fails promptly to control the bleeding. When the flow is very profuse, or is taking place in a patient nervous and frightened or young and obstreperous, it is no easy matter to keep the field clear long enough to discover the bleeding point; but, with a little patience, it is possible to see the blood ooze drop by drop or in a distinct jet from the region referred to. In persons of advanced years with atheromatous arteries nose-bleed is a conservative process and it is not to be hastily checked. The loss of blood may be considerable without doing a very great amount of damage



FIG. 70.—Dilated Vessels on Septum in Region known as "Hartmann-Kiesselbach" Spot. (*Krieg.*)

but, nevertheless, the alarm of the patient compels us to resort to a variety of measures for the purpose of checking the bleeding. Even if nothing were done in most cases a course of events similar to that observed in hemorrhage from other sources would doubtless ensue; the bleeding persists until the depletion begins to produce a sensation of faintness when the diminished blood pressure permits the formation of a coagulum to act as a natural tampon. Among the milder measures used may be mentioned, raising the hands above the head, the application of ice, held in the mouth or placed in the nostril, or applied to the root of the nose either in the form of an ice-bag or gauze wrung out in iced water. In some cases hot water, at not less than 158° F., on pledgets of cotton placed within the nostril seems to be effective, and is certainly an excellent way of stopping the hemorrhage which follows operative

work. Hot water applied to the nape of the neck is said to have a decided effect. Various other domestic remedies have been used from time to time, but if these simpler methods do not avail and provided we cannot discover the isolated point of bleeding on the septum which has been described, plugging of the nostrils is necessary. In the first place an attempt should be made to control the bleeding by plugging the anterior naris and this is best done by means of narrow strips of sterilized gauze introduced far back in the nostril, successive layers being pushed in with a probe or nasal forceps. In order that packing from the front may be effective the gauze must not be more than half- or three-quarters of an inch wide, it must be carried as far back as possible and succeeding folds must be so small as to ensure a firm solid plug. The mistake is often made of attempting to put in too much at a time. This process is simplified by the use of the Darmack packer, a metal canula through which



FIG. 71.—Bellocq's Canula.

the gauze is pushed by means of a rod or piston. The gauze may be dusted with tannogallic acid powder, or soaked in a saturated solution. If bleeding still persists and the blood finds its way back to the pharynx, we shall be obliged to pack posteriorly as well as in front. The introduction of the posterior nasal plug is accomplished with Bellocq's canula (Fig. 71), or better by a flexible catheter passed along the floor of the nose until its end appears in the oro-pharynx whence it is drawn out through the mouth and a pledget of lint attached to it by one end of a strong double ligature. By pulling the catheter back again, the plug is drawn into the posterior naris, its passage being assisted by pressure from behind with the forefinger. It is important that the size of this plug should be correct; if too small, it is drawn into the nasal fossa; if too large, it becomes wedged in the pharynx and proves ineffective. Traction now being made on the anterior end of the ligature attached to the post-nasal plug, a tampon is put in so as to completely fill the nasal

fossa. The plugs thus introduced should be removed not later than 48 hours; if left in beyond that time, they are apt to become a source of danger from decomposition. Before attempting their removal it is wise to soften them thoroughly by soaking with oil or fluid vaseline. The nasal tampon is first removed and then the post-nasal plug by traction on the distal end of the ligature which has been left hanging in the pharynx. Wolff's posterior nasal tampon consists of eight layers of iodoform gauze twelve inches long and an inch wide to which are fastened five cords of stout silk in such a way as to draw the gauze into folds. Attached to a Bellocq canula the ends of the cords are pulled into the nose where by traction on each in succession the gauze is compressed into a firm plug. The nasal hemostat of A. Cooper Rose consists of a hard-rubber tube covered with a soft-rubber bag which after its introduction is dilated with air or water. It adapts itself to the irregularities of the walls of the nasal fossa in such a way as to exercise uniform pressure (Fig. 72). The

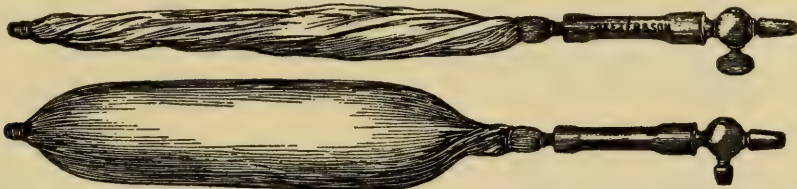


FIG. 72.—Cooper Rose's Nasal Hemostat.

withdrawal of the tube is effected by turning a stop-cock at its end and allowing the air or water with which the bag is inflated to escape. A similar apparatus is constructed out of a flexible catheter covered by a rubber hood. In treating cases of epistaxis too much emphasis cannot be laid upon the desirability of avoiding the so-called styptics, especially the iron preparations. In severe cases they are not only ineffective but they produce a very disagreeable mess in the nasal fossa and the hemorrhage which they are able to control would cease spontaneously. It is probable that the merits of "penghawar-djambi" an East Indian vegetable product highly lauded by Lubet-Barbon, Lermoyez and others, are due in part to the iron and tannin it is said to contain. It has a silky texture and its fine fibers in a tampon tend to favor formation of a clot quite independently of any hemostatic properties in the material itself. Hemorrhage of moderate severity may be checked

by directing the patient to stand erect with both arms elevated above the head, in order to divert the blood pressure from the head to the upper extremities. If the bleeding comes from the septum, pressure upon the ala of the nose with the head thrown slightly forward will control it. In mild cases a spray of peroxide of hydrogen into the affected nostril sometimes forms a sufficiently firm coagulum to stop the bleeding. A very excellent way of controlling bleeding when situated well forward and near the floor of the nose is by the introduction of the nasal plug of Bernays' sponge (W. K. Simpson), a flat disk of compressed cotton which absorbs moisture and expands to about three times its original thickness (Fig. 73). The hemostatic power of suprarenal extract is very striking, whether used locally or internally. Even in cases of hemophilia it is said

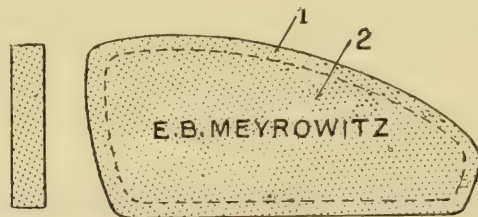


FIG. 73.—Simpson's Plug of Bernays' Compressed Cotton.

to have succeeded where other remedies had failed. It is important that fresh or aseptic solutions be used. Very unpleasant symptoms have followed the application of an infected solution. The following method of preparing a reliable solution is suggested by W. H. Bates. One part of powdered suprarenal is mixed with ten parts of boiling saturated solution of boracic acid. It is then filtered and should be boiled daily before use. Thus prepared it will retain its properties for months, although it is somewhat less effective than a plain watery solution. Under the name "adrenalin" the blood pressure raising principle of the suprarenal gland has been isolated in pure and stable form (Takamine). All the extraordinary effects observed from the use of the extract are produced by this agent in magnified degree. A permanent sterilized solution of adrenalin chloride, 1 to 1,000, diluted with distilled water or physiological salt solution, gives us one of the most valuable of recent additions to our pharmacopeia. In hemophilia very striking results have been obtained from the internal use of calcium chloride or lactate. Yet by many they are discarded as useless.

Several cases of hemophilia in which the calcium salts failed showed marked improvement after subcutaneous injections of fresh rabbit serum (Weil), and serotherapy is regarded with high favor by some in this alarming condition.

Attention has recently been called to a rare source of hemorrhage in epistaxis by Brown Kelly, who describes several illustrative cases, after a careful study of the etiology of this form of nose-bleed. The anterior ethmoidal veins, from which the blood comes in these cases, anastomose with the veins of the dura mater and with the superior longitudinal sinus. Their close connection with the intracranial veins, and the absence of valves in their walls account for their tendency to bleed. The practical value of a recognition of this source of hemorrhage lies in the fact that the flow may be checked by firm plugging of the roof of the nose, leaving the lower part of the passage free for breathing.

Whenever a localized hemorrhage can be defined, either from the septum, from the ethmoidal veins, or from an eroded turbinate body, it is better not to waste time by trying the various measures which have been described, but rather at once make direct pressure upon the spot from which the blood comes. An application of solid silver nitrate, or better the electric cautery, is generally efficacious and is certainly most satisfactory as regards the comfort of the patient. It is necessary to dry the bleeding point as thoroughly as possible with sterilized cotton and be prepared to make the application instantly on withdrawal of the cotton. Thus it is certain that many patients may be saved the discomfort and danger of plugging, a discomfort often amounting to pain both at the time and subsequently, and a danger implicating especially the accessory sinuses and the ears.

Without underestimating the significance of a nose-bleed it may be said that its importance is usually exaggerated and that most patients are unduly alarmed by its occurrence.

CHAPTER VIII.

SYPHILIS OF THE NASAL FOSSÆ. LUPUS. TUBERCULOSIS. RHINOSCLEROMA.

The primary lesion of acquired syphilis has been met with in several instances on record in the form of a small elevated papule soon undergoing ulceration which presents no special features by which it may be identified. A chronic indurated ulcer of the ala, of the turbinate body, or of the septum, accompanied by swelling of the submaxillary and sublingual glands, and a characteristic cutaneous eruption, is always open to suspicion. In the second stage of syphilis we meet with mucous patches and with ulcerative processes either superficial or deep; in the latter case, the bone is apt to be affected and more or less extensive necrosis is followed by proportionate deformity. These deep ulcerations involving the framework of the nose are usually classed in the tertiary period and begin in the form of gummatous infiltration of the mucous membrane or as an inflammation of the bone or cartilage. In the former case the necrotic process in the hard parts is secondary to ulceration involving the mucosa and the periosteum or perichondrium. In the latter case death and destruction of bone or cartilage take place primarily and are followed by ulceration of the overlying mucous membrane. In some cases the affected bone instead of becoming necrosed and exfoliating undergoes a process of rarefying osteitis, or becomes so thickened as to obstruct the nasal passage, or, on the contrary, it may be absorbed. A syphilitic process sometimes invades a sinus, involves a nerve passing through one of the various foramina, or even extends to the meninges.

Chancre and the early secondary lesions seldom require any special local treatment beyond cleanliness. They are usually painless and do not lead to extensive damage. The early recognition of *gummatous* infiltration in the nasal structures is of the utmost importance because of danger to the integrity of the framework of the nose and also because the earlier constitutional treatment is begun the more prompt is the response. Usually the symptoms are those

of ordinary coryza, and comprise sneezing, lachrymation, headache, impeded breathing and loss of smell. The secretions are free and watery and on inspection the mucous membrane is seen to be red, swollen and edematous. In the majority of cases the septum is chiefly involved and is so thickened as to cause more or less stenosis. On palpation with a probe the swelling is found to be less resistant and less hard than that of an ecchondrosis, or exostosis, but is sensitive and somewhat vascular. If the condition is not appreciated at this stage and controlled by proper treatment breaking down of tissue and destruction of bone and cartilage take place with surprising rapidity. In later stages we have presented the unmistakable odor of necrosis with profuse, bloody discharges which tend to inspissate and adhere to the ulcerated surface in the form of dark greenish-yellow scabs. Small "worm-eaten" sequestra are extruded and if a probe be used the sensation of necrosed bone is obtained. Generally when the vomer has been lost by this process the nose becomes flattened and widened and very characteristic facial disfigurement results, the so-called "saddle" nose. In some cases the external nose is involved by the ulcerative process or perforation into the cerebral cavity may take place.

The question as to the management of a nasal sequestrum resulting from syphilis is often presented and, in many cases, interference for removal of bone already dead and loose is permissible. As a rule, under active constitutional treatment a line of demarcation gradually forms and the bone affected becomes detached and may be removed without danger of damaging tissues that should be preserved. In some cases, the sequestra are so voluminous that they cannot be extracted through the natural passages and we are compelled to resort to the operation suggested by Rouge, which consists in separating the upper lip by incision along the gingivo-labial furrow and throwing up the alæ of the nose in such a way as to expose the nasal fossæ. If necessary, the margins of the vestibule are chipped with bone-forceps in order to give additional space. Although this operation appears formidable in reality it is found to be comparatively simple. The bleeding which occurs is generally controlled by pressure and after removal of sequestra the parts are simply replaced without the necessity of sutures or any special dressing. Various suggestions have been made looking to the correction of deformity resulting from syphilitic necrosis, among them the nasal

support of vulcanized rubber, suggested by Bishop (Fig. 74), and the artificial bridge of platinum or aluminum in the form proposed by Martin and modified by Hopkins (Fig. 75). My own experience with these devices leads me to believe that nothing of the sort should be undertaken until the patient has been subjected to a long course of specific medication and we are assured that his tissues are in such a condition that they will repair themselves kindly after operative interference; otherwise there is danger that the attempt to restore the contour of the nose may itself excite irritation and ulceration. The latter has happened in several instances in my own experience and a bridge has had to be removed, although, at first, the correction



FIG. 74.—Bishop's Artificial Nasal Bridge.

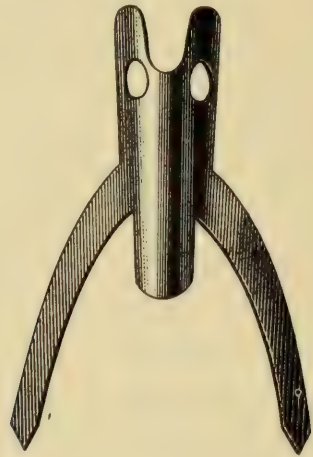


FIG. 75.—Martin's Bridge Modified by Hopkins.

of the deformity was very gratifying and the apparatus gave no discomfort whatever. In its introduction the incision of Rouge is employed, the arms of the bridge, the shape and dimensions of which must be adapted to each individual case, being imbedded on either side in the superior maxilla. In certain cases, where the deformity is not extreme, it is found to be feasible to introduce a plate of platinum or celluloid underneath the skin, either by incision along the dorsum of the nose externally or by dissection of the skin from the dorsum by means of a sharp-pointed bistoury introduced through the nostril, the plate being pushed up into the pocket thus formed. In several cases in which it was necessary to remove a metallic plate the newly-formed connective tissue excited by its presence proved to give adequate support to a previously collapsed dorsum (Fig. 76).

For the correction of these deformities the subcutaneous injection of melted sterilized paraffin, which may be molded to any desired

form and in time hardens to an almost cartilaginous consistency, has been practised on the suggestion of Gersuny. Sunken parts may be thus supported to the proper extent and the tissues are expected to tolerate the presence of suitably prepared paraffin much more kindly than they do a plate of metal.

It appears that the first to use solidifying oils under the skin was J. Leonard Corning, of New York, who injected a mixture of paraffin and cocoa butter for the purpose of immobilizing a muscle to prevent spasmodic contractions. Almost instant consolidation of the oil and

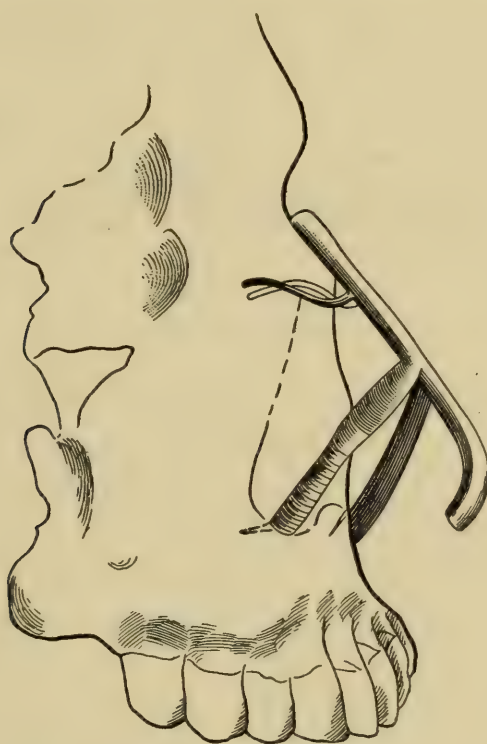


FIG. 76.—Martin's Bridge in Position.

prevention of embolism were ensured by spraying the injected area with ether. Absence of local irritation and of inflammatory reaction in these experiments encouraged the use of the method for purely cosmetic purposes. It is important that the mixture should be thoroughly sterilized and that a combination of solid and fluid paraffin should be made giving a proper melting point (not less than 104° F.). If injected too hot and fluid there is danger of causing local reaction and thrombosis, and the mass does not become solid enough to give support. To keep the mixture fluid during the process of injecting a syringe surrounded by a soft-rubber sheath or hood as suggested by Eckstein, or by a hot water chamber like that proposed

by Quinlan may be useful. An electric coil applied to the barrel of the syringe is perhaps more convenient. A rather large needle should be used and care should be taken to introduce the paraffin in a steady current. In several cases treated in this way by Harmon Smith at the Manhattan Eye, Ear and Throat Hospital a melting point of 110° was used and five minims of a four per cent. solution of cocaine were injected before the paraffin. His experience with a syringe of his own device, the piston of which is worked by a screw movement, shows that it is possible to inject the mixture in almost solid consistence (Fig. 77). It is asserted by A. B. Comstock that the mass becomes organized and actually traversed to some extent by

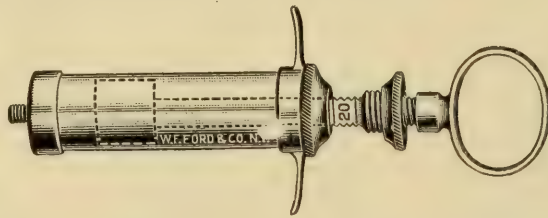


FIG. 77.—Harmon Smith's Paraffin Syringe.

fibrils of connective tissue. The very exhaustive study of the behavior and fate of paraffin in various situations and under different conditions made by Lockett and Horn shows that actual organization of the mass does not take place. Many factors are concerned, such as the temperature and consistence of the paraffin, the quantity used and the nature of the structures into which it is injected. In some cases it appears to break up into minute globules or granules, in others it becomes encapsulated, having undergone some shrinkage from absorption of its watery elements. The accidents recorded in connection with this procedure, sloughing of the skin, shifting of the paraffin, embolus in the lung, or in the eye causing permanent blindness, may be avoided by observing certain precautions. 1. The mixture must be perfectly sterilized and not too hot at moment of injection. 2. It must not be too fluid lest it be displaced. 3. A moderate amount should be injected at one time in order to avoid undue tension on the tissues at the site of operation. While the injection is being made and until the mass has been molded and become solidified it is well to make firm pressure at the root of the nose on either side. With care in these particulars it is possible to accomplish very satisfactory correction of deformity without risk.

In many cases, however, loss of tissue and cicatricial contractions compel a resort to plastic surgery by the formation of flaps from the forehead, the cheeks, or other parts of the body. Nasal deformities due to syphilis are divided by Roberts into: (1) Those in which some part of the external nose has been ulcerated away; (2) those in which destruction of the septal cartilage has caused a transverse depression of the dorsum; (3) those in which in addition to the sinking of the dorsum cicatricial retraction of the alæ or tip of the nose is present. Those included in the first group are most easily remedied, but much may be done even after extensive loss of tissue by judicious, well-planned operations. Very often a great deal of patience and a long time are required to accomplish much, but in view of the repulsive deformity and the depressed mental state observed in these cases they certainly deserve careful study. The incisions in all rhinoplastic operations should be free enough to give a generous flap and to avoid tension, the resulting scars being much less disfiguring than the original unsightly deformity.

In a few cases in which loss of tissue from specific disease has not been excessive the subcutaneous, or intranasal, operations described and very successfully practised by J. O. Roe are applicable, but in the majority the destruction has been so extensive that not enough material can be found within the nose with which to build up a supporting framework.

The constitutional treatment of syphilis of the nose is that of the disease in general. Progressive doses of a saturated solution of iodid of potash are given in milk or vichy, half an hour after meals, beginning with ten drops, a drop or more being added to each dose until we get evident signs of iodism or indications of an impression upon the process going on in the nasal chambers. In the secondary and late lesions, especially if early treatment has been neglected, a combination of mercury with iodine is indicated, either in the form of the protoiodid, one-sixth of a grain three times a day, by inunction, or by calomel fumigations. The effects of intramuscular injections of mercury (salicylate) are said to be more prompt and accurate and some of the modern preparations of iodine (sajodin, iodalbin) are taken with less discomfort than sometimes follows potassium iodide.

The use of alcohol should be prohibited and the patient should be put upon full diet, instructed to get all the fresh air possible

and to use locally a douche or spray of Dobell's solution or some similar detergent. In nursing infants the nasal obstruction is a very serious matter. A few drops of adrenalin chlorid instilled into the nares usually succeed in opening the air tract, but it is clearly most important to get the patient under the influence of specific medication as rapidly as possible. In addition a tonic and supportive treatment is often indicated.

LUPUS AND TUBERCULOSIS.

By many authorities lupus and tuberculosis are considered identical, the former being looked upon as a modified or superficial variety of the latter. Their appearance, clinical history and general tendency differ sufficiently to justify a distinction. Many of their features are perplexingly similar, some resemble syphilis in certain points, while indications of mixed infection are presented in a small proportion of cases.

Lupus occurs in the form of small nodules which coalesce and ulcerate, or absorption may take place, a feeble tendency to repair appearing at the margins of the lesions (Fig. 78). The nodules are very hard and distinct, hyperemic at first and becoming paler until finally they break down and ulcerate. The lesion spreads in a peculiar serpiginous way supposed to be characteristic. It usually begins on the anterior part of the septum, thence extending to the alæ and the skin of the face, the formation of new nodules and of a typical bluish cicatrix going on at the same time. Sometimes the process is reversed, the disease beginning in the integument. The bony structures are never involved but the cartilages occasionally are attacked. One or both nostrils may be affected and there is more or less stenosis. The discharges at first watery become thick and fetid as ulceration progresses, with tendency to crust-formation. Pain is usually complained of, and the nodules and ulcers are quite sensitive to the touch. Sometimes itching is a prominent symptom. The deformity resulting from absorption of nodules and consequent atrophy or from cicatricial contraction is often extreme. The disease is very resistant to treatment, although cases of spontaneous recovery have been met with.

Nasal tuberculosis is very rare. It may be primary but is usually secondary to manifestations elsewhere. It occurs in the form of

nodules or tumors of variable size which ultimately undergo ulceration (Fig. 79). The secretions are free, thick and offensive and may be tinged with blood. Unlike those of lupus the nodules of tuberculosis are insensitive and pale in color, and the ulcerative process of the latter does not spread in a serpiginous way and shows no tendency to repair. The crucial test in diagnosis is the presence of the tubercle bacillus, the bacillus of Koch. It is hard to find in the

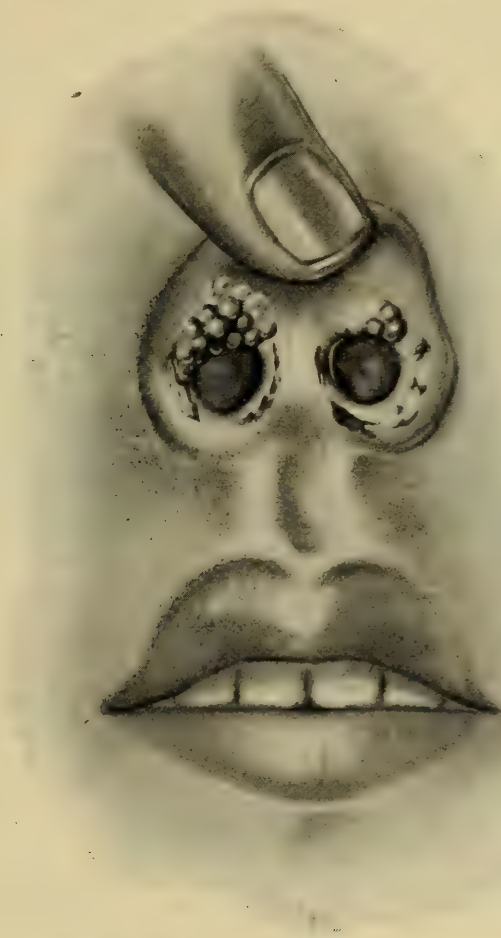


FIG. 78.—Lupus of Anterior Nares (*Gerber*), showing lesions involving mucocutaneous junction and attempts at repair.

scrapings but is pretty sure to be discovered in secretion of a tuberculous tumor, or nodule. General symptoms depend upon the activity and extent of coincident lesions in the lung or elsewhere. Antisyphilitic treatment generally aggravates the local condition both in lupus and tuberculosis, and yet the use of mercury has recently been strenuously advocated in tuberculosis. If thought desirable the tuberculin test may be resorted to, a definite reaction generally being exhibited in cases of genuine tuberculosis, as well as in lupus.

Its value in detecting latent or incipient cases or confirming suspicion in those giving no positive sign is unquestionable. Its use should be restricted to cases in which a diagnosis is of the utmost importance in order that vigorous measures may be taken to arrest the disease. Large doses, which involve corresponding violent local reaction, are not required and proofs are abundant that they encourage dissemination of the bacilli. But experience with smaller quantities, two to five milligrammes, seems to have demonstrated its innocuousness, and its reliability for diagnostic purposes. The diagnostic skin reaction with tuberculin ointment (Moro), the vac-



FIG. 79.—Tuberculosis of Turbinates on Right Side and of Left Side of Septum with Perforations. (Gerber.)

cination test (von Pirquet), and the ophthalmo-reaction (Calmette) are all attracting attention as safer substitutes for subcutaneous injection. Reports are conflicting as to their reliability, but there is reason to believe that they may prove of value.

The tubercular tumor may appear on the septum or may select as its site a turbinate body; the tubercular ulcer, formed by the coalescence and breaking down of two or more miliary nodules generally begins at the anterior part of the septum whence it may extend to the external parts. Perforation of the septal cartilage may take place. It is difficult to make a diagnosis from the appearance of the ulcer which varies greatly in different cases. It may be round or ovoid, its edges may be flat or elevated, its surface may be smooth, covered with grumous secretion, dotted here and there with caseating tubercles, or obscured by masses of exuberant granulation.

The *treatment* of lupus and of tuberculosis is conducted on similar lines. After careful cleansing of the parts all morbid deposit

is thoroughly removed by means of the curette and the exposed area is then rubbed with pure lactic acid. The wound must be kept scrupulously clean with Dobell's solution or a carbolized alkaline wash, and if reaction and pain are excessive the surface is coated with an emollient ointment. One of the best is a mixture of orthoform with albolene or lanolin, a drachm to the ounce. General medication must be resorted to according to indications. In tuberculosis, as a rule, we are dealing, not with a local disease, but with a general diathesis, and the importance of good hygiene, pure air and sunshine, nutritious diet and supportive treatment is beyond question. Phototherapy seems to have been successful in lupus but not in tuberculosis.

It is clearly proven that tubercle bacilli may be found in the nasal fossæ of the perfectly healthy but especially of those attendant upon tubercular subjects, hence the necessity of care to avoid producing abrasion of the mucosa through which the germ might find entrance to the system.

RHINOSCLEROMA.

The opportunity of studying rhinoscleroma in this country is extremely rare. In 1893 Jackson could discover only three reported cases. Since then a few have been added to the list, with one exception having been imported from abroad. This disease was first described by Hebra, whose account in some particulars is still accepted as correct. It is a chronic inflammatory process involving the mucous membrane of the upper air tract, usually beginning in the nose at the anterior part of the septum, and sometimes extending thence to the pharynx, larynx and even to the trachea. It is characterized by extreme thickening and ivory-like hardness of the affected parts, which are sensitive to the touch but are free from spontaneous pain. It develops very slowly without edema or acute symptoms. It eventually causes great external deformity as well as internal distortion from cicatricial retraction and gradual filling of the passages with indurated masses. The tip of the nose becomes enormously broadened, hard and lobulated. When the pharynx is invaded the palate is thickened, leathery and covered with fine scales. The smooth nodular appearance of the external nose is compared by Kaposi to that of keloid. In some cases the course of

the disease is reversed and it appears on the palate, in the larynx, or even in the trachea before any signs are present in the nares. The evidence seems to be almost convincing that a rare lesion described as *chorditis hypertrophica inferior* and what is known as Stoerk's blenorrhea are identical with rhinoscleroma. This view is held by Freudenthal, who has given a very careful and complete report of a case under his observation. The typical bacterium of rhinoscleroma is said to be the capsule bacillus of Frisch, resembling the pneumococcus of Friedländer, but not easily demonstrable. In a case reported by Roe, which is said to be the first instance of the disease originating in this country, it was difficult to find the bacilli in the cells, although certain bacilli were cultivated not unlike the pneumococcus.

The *treatment* of the condition appears to be very unsatisfactory. The morbid tissue may be removed by the knife, or by curetting, or may be destroyed with the galvanocautery. Various chemical caustics, especially lactic acid, have been tried, with only temporary amelioration. Internal medication makes no impression on the lesion. In some cases the nodules soften and break down, as in one reported by C. W. Allen, in which almost the entire mass sloughed away, exposing the bones of the upper jaw and the nasal septum. Generally the disease is extremely chronic, although the duration of Roe's case was only three and a half years. Its resemblance to malignant disease and the fact that the nose is often not its primary site have suggested the propriety of substituting the name "granulation sarcoma," or a similar title, for rhinoscleroma, which latter is manifestly inappropriate. In this connection Freudenthal suggests that good results may be possible with injections of Coley's fluid as in sarcoma, and he refers to the favorable reports of Pawlowsky with injections of *rhinosclerene*. In one case, that of Lubliner, the lesion absolutely disappeared after an attack of typhoid fever.

CHAPTER IX.

NASAL NEUROSES. HAY FEVER. NASAL HYDRORRHEA.

Neurotic disturbances met with in the nose may affect the special sense of smell, or the secreting function of the mucous glands, or may excite certain reflex phenomena.

Parosmia is a perversion of the sense of smell in which the subject perceives odors which do not exist. When the odor is offensive the term *kakosmia* is applied. It may be due to a pathological change in the nerve terminations or to some central nerve lesion. This phenomenon has been met with as a precursor of insanity and in the course of syphilis, hysteria and epilepsy.

An exaggerated sense of smell, or *hyperosmia*, occurs in conditions of neurasthenia and in hysteria as well as in certain sexual derangements in women.

Anosmia, or loss of smell, may be partial or complete and may result from injury or disease affecting the olfactory nerve or the nerve centers in the brain. It may be the result of some peripheral irritation, such as pungent gases or strong local applications to the nasal mucous membrane might produce. The sense of smell is also lost or impaired in simple acute and chronic inflammatory conditions, as a sequel of grip, and sometimes in connection with adenoids and polypi, or other lesions causing nasal obstruction. Finally loss of the sense of smell may be referred to functional or reflex disturbances. Thus anosmia is divided into three classes (Onodi). (1) Essential or true anosmia, central or peripheral, depending on the part of the olfactory nerve affected; (2) mechanical or respiratory anosmia resulting from atresia of the nares, congenital or acquired. Under this head are included conditions which prevent access of air to the nasal chambers, such as deformities, new growths and inflammatory swellings; (3) functional anosmia, as in hysteria, and as a reflex from ovarian or uterine disturbance, from psoriasis buccalis, and from cauterization of the inferior turbinates.

The prognosis of anosmia depends in great degree upon its cause. Many cases even of long standing are benefited by treatment, or

recover spontaneously, especially when the condition is a sequel of influenza or neurasthenia. In advanced atrophy of the nasal mucous membrane the loss of smell is usually complete and permanent.

Local treatment should be conducted with caution. In the first variety the mode of treatment is governed by the cause and its location. The relief of mechanical anosmia is generally feasible by removing the nasal impediment. In functional anosmia stimulation of the olfactory tract with galvanism and the internal use of general tonics are sometimes effective.

HAY FEVER.

Since the subject of reflex neuroses was first brought up an immense number of affections have been traced to disease of the nasal chambers. It must be admitted that many of these relationships have their origin in the imagination of the observer. In other words, a genuine nasal reflex is rare. The typical, most familiar example of a nasal neurosis is hay fever, at times accompanied by reflex asthma. It is otherwise known as hyperesthetic rhinitis, or periodical vasomotor rhinitis, as well as by other titles. Three conditions are essential to its development, the neurotic temperament, nasal hyperesthesia associated or not with a deformity or neoplasm of the intranasal structures and, finally, an exciting cause in the shape of some irritant, either pollen, or emanations of some kind, animal or vegetable, or certain peculiar atmospheric states. By some a nervous temperament is not considered a requisite factor, the neurotic symptoms attending an attack being looked upon as a consequence rather than a cause. It is allied in many of its features to other neurotic disturbances, paroxysmal sneezing and similar phenomena known as autumnal catarrh and rose cold. These occur independently of any special period of the year and are sometimes known as pseudo-hay fever. Rose cold is so called from its occurrence in June, the month of roses, although the attacks are not limited to that period. It is a well known fact that sneezing, cough, and lachrymation may be caused by irritation of certain areas in the nasal mucous membrane. It is possible to demonstrate with a probe sensitive regions but the idea that they are always to be found in similar situations in all individuals is erroneous. The influence of heredity as a predisposing cause is unquestioned;

in at least half the cases of hay fever we succeed in getting a history of some neurotic manifestation in other members of the family. It is a curious fact that the disease seems to be limited to the Anglo-Saxon race and it is said to be more prevalent in males than in females. It is not always easy to discover the irritant which excites an attack. Dust of any kind, tobacco smoke, pollen of various plants, as rag-weed, or golden-rod, and emanations from certain animals are capable of producing it. The name rose cold is derived from the fact that symptoms of this kind are induced by roses, but the famous case of J. N. Mackenzie in which characteristic attacks were caused by an artificial rose proves that the phenomena may be of purely psychical origin. Many interesting cases are on record in which attacks closely resembling hay fever have developed in connection with renal irritation. Paroxysmal coryza of nephritic origin subsides with the relief of urinary symptoms and is not periodic but recurs if for any cause the renal derangement becomes aggravated.

Haig, Bishop and others who have made extensive study of this subject, attribute hay fever to an excess of uric acid in the fluids of the body. Daly, Bosworth and others profess to find invariably some intranasal abnormality which acts as an exciting cause. Price-Brown traces the outbreaks to an antecedent hypertrophic rhinitis. Excessive alkalinity of the nasal secretions is thought to explain the condition in some cases. Paulty elimination and chemical changes in the secretions are regarded by some as prominent factors in etiology (Braden Kyle). Their existence is not to be denied, but whether as cause or effect remains to be determined. The argument in support of the uric acid as well as of the nasal stenosis theory of causation is measurably weakened by the fact that these states are very prevalent in those without a suspicion of hay fever. That they often coexist admits of no question; that they are occasional excitants is very probable. An attack is sometimes provoked by indiscretion in diet and consequent digestive derangement. Extraordinary mental emotion or nervous excitement will aggravate or may even induce an attack. Certain localities seem to be relatively free from the disease and yet some suffer where others are exempt, and again the latter may succumb in a region where they have previously escaped. Hay fever usually occurs in adolescence or early middle life, but has been observed in children and even in

infants. It is essentially a disease of the well-to-do, or of those whose affairs involve more or less nerve tension and excitement. Yet not a few cases have come to my notice in those whose lives were placid and free from care, but such persons have usually given a highly neurotic individual or family history.

The symptoms of hay fever vary in different individuals and in the time when they appear. Usually the attack begins early in August and ceases with the advent of frost or cold weather. In some seasons the outbreak is delayed and occasionally its duration is abbreviated, whence the inference that atmospheric states have an influence. One of the earliest symptoms is a sensation of itching and burning of the eyelids, particularly at the inner canthus. Sometimes there is decided itching in the pharynx or roof of the mouth. This may persist for hours or days and is accompanied by sneezing and suffusion of the eyes. The attack may come on with great abruptness or by degrees. Stenosis of the nostrils results from turbinate turgescence and presently a serous discharge begins which soon becomes remarkably free. Mental as well as physical depression, especially in very neurotic subjects, is pronounced. The eyelids frequently become very much swollen and there is marked photophobia. In some cases asthma supervenes, resembling, in all respects, the ordinary attacks of this affection. Examination of the nose may show nothing more than would be expected in the early stage of acute catarrhal rhinitis, but the membranes are much less injected or are actually pale and soggy in appearance, and the serous effusion is much more abundant. In the interval of health nothing abnormal is found in the nose, or some deformity is discovered which may be reasonably looked upon as an aggravation if not the cause of symptoms.

The *prognosis* as to the attacks is favorable; so far as the cure of the disease or the tendency to it is concerned, we cannot speak so hopefully except possibly in those cases in which we are able to discover a positive nasal lesion. The prognosis when little or no structural change can be detected and in individuals of highly neurotic temperament is decidedly less favorable.

In any case we are justified in promising some degree of amelioration of symptoms as a result of treatment. Many patients prefer to secure exemption from the trouble by resorting to localities where experience has taught that they may be reasonably free from dis-

turbance. A sea voyage sometimes affords escape. Residence at a moderately high altitude appears to give immunity to some. The use of nerve tonics and sedatives is considered of value, and stimulants give temporary relief, but their use is not to be advised except in extreme cases.

The importance of internal medication is urged by adherents of the uric acid theory as well as by many who find the first cause of hay fever in the nasal fossæ. Without doubt cures have followed correction of nasal anomalies, yet the attention given to hygiene, diet, exercise and clothing, not to mention the use of tonics, by most practitioners shows that sole reliance is not placed upon local treatment. Bishop, who is a stout advocate of the uric acid idea, gives the acid phosphates (Horsford) in one or two teaspoonful doses night and morning, and never fails to stop an attack by a combination of atropia and morphia in suitable cases, one part of the former to fifty of the latter, one-sixteenth to one-eighth of a grain of this mixture being given to an adult. Atropine has always been well thought of in asthma and seems to be especially adapted to that associated with hay fever. In extreme cases the addition of morphine may be desirable, but the use of such drugs should never be left to the discretion of the patient. Iodide of potassium, or sodium, or syrup of hydriodic acid finds favor with some, while others recommend strychnia in full doses, or the three valerianates of zinc, iron and quinine, one grain each. The internal use of thyroid extract has not been extensive enough to authorize a positive conclusion. The testimony offered by P. Heymann is favorable but not final. Sajous also commends desiccated thyroid in two grain doses twice a day for three days and then once daily, fortified by one-fiftieth of a grain of strychnia three times a day. The former is believed to enhance the "catabolism of toxic wastes"; the latter to "stimulate the vasomotor center and increase the oxygen intake." It is apparent that we have no specific for hay fever and in many cases the administration of drugs does more harm than good.

In these days when the accessory sinuses are attracting so much attention perhaps it is not surprising that they should be accused of joining the hay fever conspiracy. Accordingly we find E. Fink protesting that the sinuses, and especially the antrum, provide the secretion which is one of the prominent features of the disease. Insufflations of aristol made through the ostium are said to cure the

most obstinate case. A degree of suspicion is thrown on the genuineness of this contention by the earnestness with which treatment of the coincident neurasthenia is urged. This idea has been adopted by J. E. Schadle who believes that irritation of the sensory and sympathetic fibers from the posterior dental, the anterior dental and Meckel's ganglion distributed to the lining membrane of the antrum, is the etiological factor in hay fever and in many cases of asthma. An essential predisposing condition is an abnormally large ostium, or a supplementary antral orifice, through which foreign particles are admitted with unusual readiness. It is thought that one with ostia perfectly normal in size and situation is not liable to these neurotic disturbances. The familiar phrase "unstable nervous organization" is invoked to help on the theory. The illustrative cases cited are neither numerous nor wholly convincing. The treatment based on the foregoing theory consists of thorough irrigation of the antral cavity through the normal opening, or an artificial opening in the inferior meatus, until the return fluid is clear and free of sediment, followed by applications of mentholized oil or insufflation of thymol iodide. The procedure provokes no objection and relief is said to be almost immediate in many cases.

Bilateral resection of the nasal nerve has been recommended in rebellious cases of hay fever and in paroxysmal coryza (E. S. Yonge). The nerve may be reached by an incision curving from just above the inner canthus upward and outward to the anterior orbital foramen. The anterior ethmoidal artery having been separated from the nerve, about a quarter of an inch of the latter is resected close to its exit from the foramen. Anesthesia of the nasal mucosa, together with abolition of all hyperesthetic symptoms, is said to result. Even with the memory of misery still keen it is unlikely that very many sufferers will be persuaded to submit to a surgical procedure of this kind. A similar end is proposed in the use of intraneural injections of alcohol (Stein). On the theory that the fifth nerve is at fault its branches distributed to the mucous membrane of the nose are to be paralyzed by injections either externally within the orbit where the nasal nerve enters the ethmoidal foramen, or intranasally where the *anterior* division enters the nasal fossa through one of the cribriform perforations and in the sphenothmoidal fossa near the posterior end of the middle turbinate where the *posterior*

branch of the nerve is distributed. Experience with this method is still too limited to be reliable.

Dry, hot air has been used with alleged benefit. The face of the patient is covered by a sort of hood, or basket, in which are enclosed half a dozen electric lamps (Hürlimann). A special apparatus for projecting hot air would seem to be more convenient.

Of local remedies nothing gives an equal degree of comfort as cocaine applied to the mucous membrane of the nose on a pledget of lint or in the form of a spray. It should never be entrusted to a patient, and when a strength greater than four per cent. is required for the desired effect its advantages are overbalanced by a detrimental impression upon the nervous system. Moreover, its action is so transient that we are forced to conclude that its indiscriminate recommendation is not justifiable. The evils of the cocaine habit, a risk not to be ignored, are unhappily familiar.

The extract of the suprarenal gland possesses astringent and hemostatic qualities, and is, at the same time, a tonic to muscle fiber. A great advantage of this agent is that it may be used liberally without ill effects. Not only is it free from toxic properties itself, but it seems to possess the power of limiting the toxic and prolonging the anesthetic effects of cocaine with which it may be used in combination or alternately.

A formula for a permanent solution which may be kept for several months is thus given (L. S. Sommers):

R_x

Adrenal.....	20 grains.
Phenic acid.....	2 grains.
Beta-eucain	5 grains.
Distilled water	2 drachms

M. Macerate for ten minutes and filter.

The effect of the solution in blanching and retracting the mucous membrane is apparent at once, reaches its maximum in from three to five minutes, and lasts several hours. It causes slight smarting which soon subsides. In moderate cases a single application may give permanent relief. More immediate and pronounced results are claimed by some if the adrenal be given internally as well as used locally. One grain of the powder, representing eight grains of the fresh suprarenal gland, is given in tablet or capsule every two hours,

until dizziness, or cardiac palpitation, develops, or the nasal mucosa shows the characteristic effects of the drug. For local use the following solution applied in spray or on cotton is satisfactory (E. F. Ingals):

R

Cocaine hydrochlorategr. iiss.
Soda biborategr. v
Suprarenalin (1-1000)dr. i
Glycerinedr. ss
Camphor wateroz. i

A one per cent. aqueous solution of resorcin is said by Oppenheimer to be an almost perfect preservative.

A solution of suprarenal extract with chloretone is fairly permanent. Each minim represents one grain of fresh gland and the mixture contains 0.8 per cent. of chloretone. Adrenalin chloride mentioned in the chapter on Epistaxis has similar efficacy and is more stable. During the paroxysms of hay fever more or less comfort is derived from inhalations of camphor and menthol, equal parts in an inhaler, or in albolene solution so mild as to be quite free from irritating effects.

In a small proportion of cases a weak solution of chromic acid, $\frac{1}{8}$ of a grain or less to the ounce of water, has been found efficacious in hay fever (Macdonald). A combination of muriate of quinine, 1 drachm, glycerite of carbolic acid, B. P., 1 ounce, and perchloride of mercury, $\frac{1}{1000}$ part (Andrew Clark), is useful in cases exhibiting no structural change. It is customary to cleanse the nostrils thoroughly, spray with cocaine in 10 per cent. solution, and then paint the mucous membrane of the nasal fossæ with Clark's solution. Considerable burning is caused in spite of the cocaine, and for the next twenty-four or forty-eight hours a violent attack of coryza occurs. Massage of the mucous lining of the nose, or mechanical vibration, has been advised. The assertion is made by Alfred Denker that the attack is mitigated and recurrence prevented for several years by massage with a ten per cent. oily solution of eucalypten. The surfaces are first anesthetized with cocaine adrenalin solution and daily manipulations are practised for three or four minutes with gradually increasing pressure. The use of three different medicaments in this way leads to some confusion.

In cases accompanied by structural anomalies or new growths it is

possible to accomplish much more definite results than in others, Ecchondroses and exostoses of the septum impinging upon a turbinate act as exciting causes. Hyperplasia of the turbinate tissue in contact with the septum and nasal polypi are well known sources of irritation, and the removal of these various abnormalities is almost always followed by improvement if not absolute cure. Sensitive spots, identified by exploration with the probe, either upon the septum or the turbinate bodies, should be destroyed by the galvano-cautery or chemical caustics.

The observation that the internal use of ipecac prevents the local effects of this drug in certain individuals has led to experiments with plants known to cause similar disturbances, especially the rag-weed (Holbrook Curtis). Some very curious results are recorded with tinctures and fluid extracts of golden-rod, lily of the valley and other plants. The contradictory reports made by different experimenters prove the large psychical element in these cases, which adds greatly to the difficulty of estimating the value of any therapeutic agent. The personal equation, both as to the patient and the observer, the possible number and variety of exciting causes, atmospheric conditions and other modifying influences must all be considered. The antitoxin treatment developed by Dunbar, of Hamburg, is still on trial. By some it is discarded, by others it is hailed as a specific. The truth may lie between, and at any rate too much praise cannot be accorded the zeal and honesty of investigations in this line. Under the name "pollantin" is offered a hay fever serum extracted from the pollen of various cereals. It is made in fluid and in powder, the latter being preferred on account of its superior stability. Only the antitoxin derived from the particular pollen causing the disease in a given case is expected to be efficacious. Failure to recognize this fact may be one cause of disappointment. The suitable "pollantin" must be selected and it should be used in moderate quantity, at the very outset of the attack. In addition we are urged to exclude the night air from sleeping-rooms and to avoid all possible sources of local irritation. Nearly all authorities agree upon the importance of these precautions, and it should be noted that their strict observance is often followed by amelioration of symptoms without any medication whatever. A preparation similar to Dunbar's serum, Weichert's "graminol," has been used with equally varied results.

On the theory that some inhaled irritant is the chief exciting cause a "nostril filter" is recommended as a prophylactic by Mohr, and a similar contrivance is suggested by A. C. Heath. A lady under my care suffers much from golden-rod and dust of almost any kind, but is able to protect herself by wearing a damp cloth over the nose and mouth. Osteopathy worked wonders with her a year ago, while the past season it utterly failed and she had to resort to change of climate and keeping the nostrils annointed with a simple unguent like vaselin or lanolin.

The tendency to attacks of hay fever and their severity seem to diminish with advancing years, and if immunity for several successive seasons can be obtained, if the nasal membranes can be restored to a condition of health and if, at the same time, the neurotic disposition can be modified we may hope for a disappearance or a mitigation of the disease. The prominence of the neurotic element varies greatly in different cases and in the same case in different seasons, but is never absent. In some individuals attacks of sneezing occur on rising in the morning, on sudden exposure to bright sunshine, or after the ingestion of a hearty meal. A cure of these cases has been accomplished by hypnotic suggestion. Not every one is amenable to hypnosis, yet, contrary to the general belief that hypnotism is applicable only to "fools and weaklings," the experience of Lloyd Tuckey shows that "strong, muscular and intelligent men and women" are the best subjects. In many cases, however, a nasal lesion must be removed in order to obtain a permanent cure.

In spite of all that can be done the melancholy spectacle is all too frequent of an individual who has exhausted the resources of the general practitioner, who has experimented with every known quack nostrum, who has had most of his original intranasal structures removed by the ardent rhinologist and who still remains the unhappy victim of hay fever.

NASAL HYDRORRHEA.

A flow of watery secretion from the anterior nares under the name of nasal hydrorrhea is looked upon by some authorities as a modified form of hay fever. It occurs independently of season and is, undoubtedly, a vasomotor affection. In some cases on record it seems

to have been of malarial origin, occurring periodically, and accompanied by chills and fever, a cure resulting from the administration of quinine. The few cases reported show great variation in clinical history, nasal discharge being the only fixed symptom. The quantity of secretion is more or less abundant, even a pint or more of fluid escaping in twenty-four hours, sometimes from one and again from both nostrils. It seems to have been observed in one instance as a symptom of general edema, in other cases associated with cerebral disease, and it has been seen in hysterical patients. Under these circumstances it is, of course, merely a symptom, in other cases the hydrorrhea is so pronounced as practically to constitute in itself a disease. A serous secretion from the nostril in nasal polypi and in polypi of the accessory sinuses is very common, but under these circumstances must be placed in another category. In connection with trifacial neuralgia and certain genito-urinary disturbances in either sex it is purely a reflex disorder. The subjects of this affection are very sensitive to atmospheric conditions and the discharge is usually preceded by sensations of tickling in the nostrils and attacks of sneezing.

It is usually met with in adults, the case reported by Cathcart in a girl nine years old being quite exceptional.

Examination of the nose shows turgescence of the mucous membrane, which is redder than normal and is bathed in watery secretion. In cases of long standing the membranes become somewhat pale. There may be considerable nasal stenosis and paroxysms of reflex asthma may occur.

If this affection is a symptom of a general diathesis it is obvious that local treatment alone cannot be efficacious. In view of the evidence of a malarial element the use of quinine is always indicated. Mustard foot baths with atropine and morphine internally have been known to check an attack. Violent local measures should be avoided, but relief may be obtained from applications of menthol in alcohol or, if distress is extreme, by the use of cocaine. A more prolonged effect from adrenalin has been claimed in some cases, while in others it has utterly failed. Decortication of the nasal mucous membrane recommended by Mouré and daily massage of the nasal fossæ with cotton tampons soaked in borated vaseline and containing a little cocaine advised by Jankelevitch may be resorted to in the failure of other measures. The internal use of strychnin,

hydrotherapy and the external application of the continuous electric current have each been found beneficial. Applications of hot air, as described in the chapter on Rhinitis, have been effective in the hands of G. Mahu, who seems to have observed an extraordinary number of these cases.

This condition must not be mistaken for the very rare phenomenon which has been the subject of recent study, namely, the spontaneous discharge of cerebro-spinal fluid from the nose. Undoubtedly some of the latter have been wrongly reported as cases of nasal hydrorrhea, and it is very clear that they have no relationship with hay fever. One of the earliest cases described was in a girl of fifteen who had hydrocephalus from birth (Leber). She had severe headaches, dizziness, and impaired vision and, finally, an epileptic fit which was followed by the continuous escape of fluid from the left nostril.

In another case intermittent discharges from the nose were preceded by severe headache, chiefly over the left eye, top and back of the head. When the flow was established the patient was relieved and appeared to be in perfect health in other respects (St. Clair Thomson).

In one case the discharge of watery fluid was preceded by very grave cerebral disturbance indicative of pressure as shown by the existence of optic neuritis and the occurrence of symptoms of tumor of the brain (Freudenthal). The flow was continuous night and day, in this respect differing from that of nasal hydrorrhea which usually stops at night. In the chemical analysis of the fluid, however, we have a definite means of differentiating these conditions. The chief points which serve to identify cerebro-spinal fluid are first, its clear watery character; second, its low specific gravity; third, the small amount of proteid in it and the absence of albumin, and fourth, the presence of a substance "possibly related to pyrocatechin which reduces Fehling's solution but is not dextrose." The history of these cases shows the importance of avoiding measures intended to check the flow, since cerebral symptoms recur almost as soon as any obstacle is offered to the escape of the fluid. It is remarkable that the leakage may continue indefinitely without any marked impairment of the general health.

THE PHARYNX.

CHAPTER X.

ANATOMY AND PHYSIOLOGY OF THE PHARYNX.

The pharynx extends from the posterior nares to the cricoid cartilage and is divided into three portions, the upper, or *rhinopharynx*, ending at the level of the palate, the middle, or *oropharynx*, extending to the vestibule of the larynx, and the lower, or *laryngopharynx*, leading into the esophagus at the lower border of the cricoid cartilage.

The superior division has opening into it the orifices of the posterior nares, or choanæ, those of the Eustachian tube on either side and below it is continuous with the buccal pharynx. Lesions in this division of the pharynx are of special interest from their relation to the Eustachian tubes, the sphenoidal sinus and the posterior nares. The orifice of the tube on either side is on a line with the inferior turbinate body and between them is sometimes found a mass of lymphoid tissue called the Eustachian or tubal tonsil. It is generally continuous with other adenoid vegetations on the wall of the rhinopharynx and hardly deserves an independent name. The posterior lip or margin of the Eustachian tube is much more prominent than the anterior and forms a decided eminence called the Eustachian cushion. Behind it is a depression of considerable depth, the fossa of Rosenmüller, where large quantities of adenoids often accumulate and their removal with a large sharp-edged instrument is attended by some risk to the cushion.

The middle division of the pharynx, or oropharynx, contains aggregations of lymphoid tissue between the pillars of the fauces known as the palatal or faucial tonsils, and similar masses at the base of the tongue called the lingual tonsil. The former present pathological conditions of great importance in both an acute and a chronic form. Acute disturbances of the lingual tonsil are less common, but the latter lymphoid mass often undergoes considerable enlargement and becomes a source of functional derangement affecting the pharynx

and the larynx. The lingual tonsil also at times is involved in phlegmonous inflammation. Cases reported as abscess of the tongue are doubtless often a suppurative inflammation involving this structure. Across the base of the tongue we also see, especially in adults, a varicose condition of the blood-vessels quite independent of any special or marked change in the lymphoid tissue. An interesting and curious phenomenon at the posterior wall of the pharynx, visible through the mouth in the form of a pulsating vessel, has attracted a good deal of attention. It is either an abnormally placed ascending pharyngeal artery or a tortuous internal carotid as often seen in the aged. It is important only when we are called upon to use the knife in this region.

The laryngo-pharynx, the third division, is of special interest to the laryngologist in connection with foreign bodies, which are apt to lodge at the point where the pharynx merges into the esophagus, and in connection with neoplastic formations invading it from the larynx. Many cases of dysphagia, or odynphagia, have their origin not in the swallowing track, but in the laryngeal cavity where compression by the inferior constrictor causes a feeling of obstruction or a sensation of pain.

The pharynx measures from above downward about four and a half inches. Its narrowest portion is at its junction with the esophagus. Its lateral diameter is greater than its anteroposterior, being widest on a level with the cornua of the hyoid bone. Its wall is composed of a fibrous coat, the pharyngeal aponeurosis, which is lined by mucous membrane and surrounded by muscles, the pharyngeal constrictors.

The pharyngeal aponeurosis is best marked at its upper portion where it is attached to the posterior part of the body of the sphenoid bone in front of the pharyngeal tubercle. Thence it runs outward to the apex of the petrous portion of the temporal bone to the cartilage between it and the occipital bone to the Eustachian tube and the internal pterygoid plate.

The mucous membrane is closely adherent to the base of the skull; in parts it is thick and spongy; in the neighborhood of the openings of the nares and Eustachian tubes it is thinner, while below it is pale and arranged in longitudinal folds. It is freely supplied with lymph follicles and racemose glands. Its epithelium is ciliated in the rhinopharynx and becomes stratiform in the lower portion (Fig. 80).

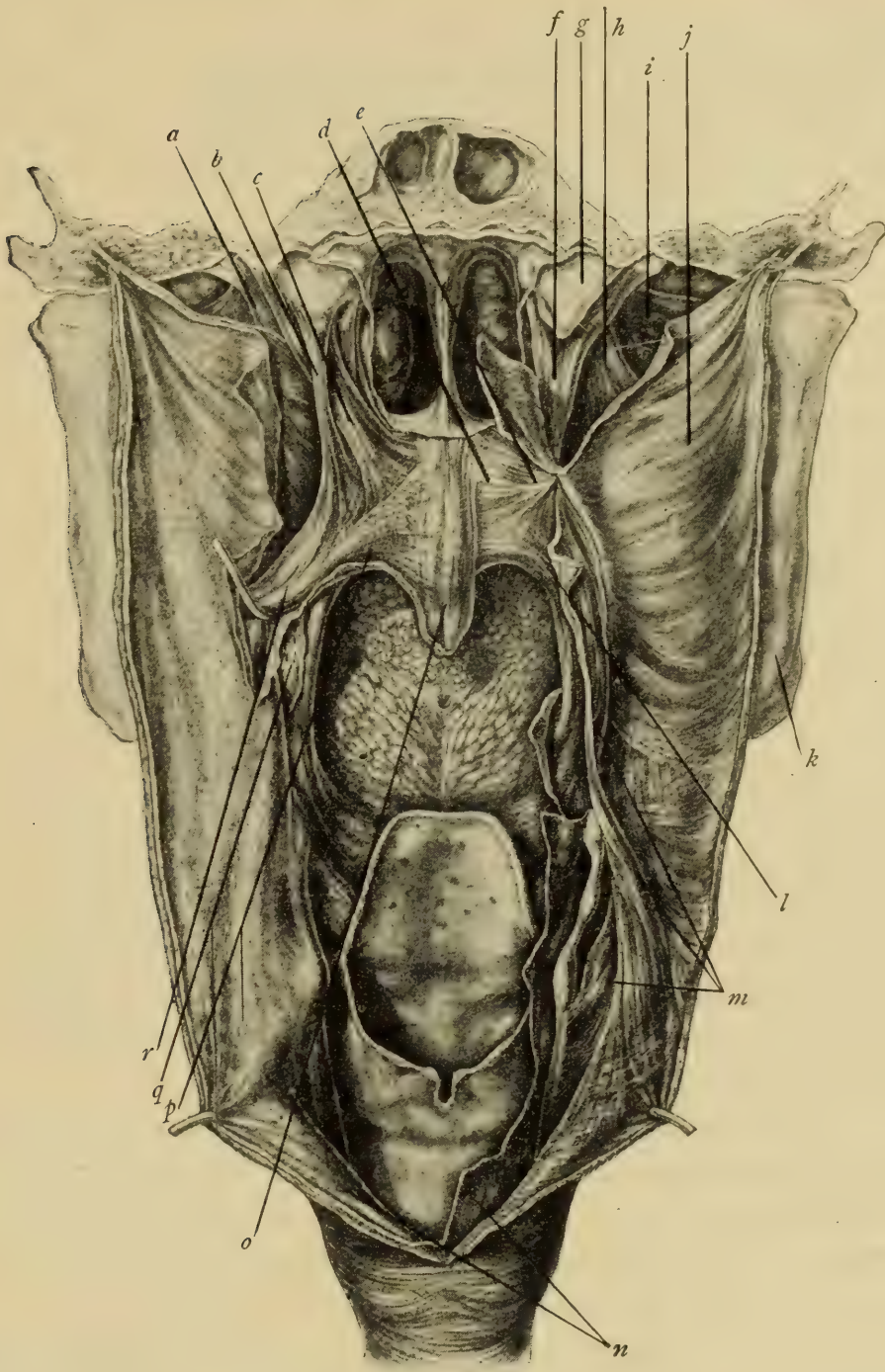


FIG. 80.—Muscles of Soft Palate Seen from Behind. (Deaver.)

a, Tensor palati muscle; *b*, salpingopharyngeus muscle; *c*, levator palati muscle, *d*, aponeurosis of soft palate; *e*, tensor palati tendon; *f*, tensor palati muscle; *g*, Eustachian tube; *h*, internal pterygoid muscle; *i*, external pterygoid muscle; *j*, pharyngeal aponeurosis lining constrictors; *k*, lower jaw; *l*, palatoglossus muscle; *m*, palatopharyngeus muscle; *n*, mucous membrane; *o*, azygos uvulae muscle; *p*, posterior fasciculus of palatopharyngeus muscle; *q*, tonsil; *r*, palatopharyngeus muscle.

The muscles of the pharynx are the three constrictors, the superior, middle and inferior, fortified by fibers of the stylo- and palato-pharyngei muscles. The superior constrictor surrounds the upper part of the pharynx with the exception of a semilunar space on either side named the "sinus of Morgagni" which is filled in with the pharyngeal aponeurosis and contains the Eustachian tube and the levator palati muscle. It is quadrilateral in shape and arises from the lower third of the edge of the internal pterygoid plate and its hamular process, from the pterygo-maxillary ligament, from the posterior fifth of the mylohyoid ridge and the side of the tongue. The fibers pass backward to meet in the median raphe.

The middle constrictor is fan-shaped and arises from the lesser cornua of the hyoid, from the whole length of the greater cornua, and from the stylo-hyoid ligament. Its fibers are also inserted into the median raphe. The upper ones overlap the superior constrictor and reach to the basilar process of the occipital bone, while the lower fibers are included within those of the inferior constrictor.

The inferior constrictor is a thick muscle, very powerful, which arises from the thyroid cartilage behind the oblique line and superior tubercle as well as from the inferior cornua and from the sides of the cricoid behind the crico-thyroid muscle. The upper fibers overlap the middle constrictor while the lower ones are continuous with the muscle fibers of the esophagus. Near its upper border the superior laryngeal nerve and artery pierce the thyro-hyoid membrane. The recurrent laryngeal nerve enters beneath its lower border behind the crico-thyroid articulation.

The stylo-pharyngeus arises from the base of the styloid process internally and passes downward and inward between the superior and middle constrictors. Its fibers diverge, some joining the palato-pharyngeus to be inserted into the posterior border of the thyroid cartilage, and the rest mingling with the constrictors.

The palato-pharyngeus forms the posterior pillar of the fauces. It arises from the aponeurosis of the soft palate by two heads separated by the insertion of the levator palati. The upper head blends with its fellow of the opposite side while the lower, which is the thicker, follows the curve of the posterior border of the palate. It also has its origin by one or two narrow bundles from the lower part of the cartilage of the Eustachian tube known as the salpingo-pharyngeus muscle. It is inserted by a narrow band into the pos-

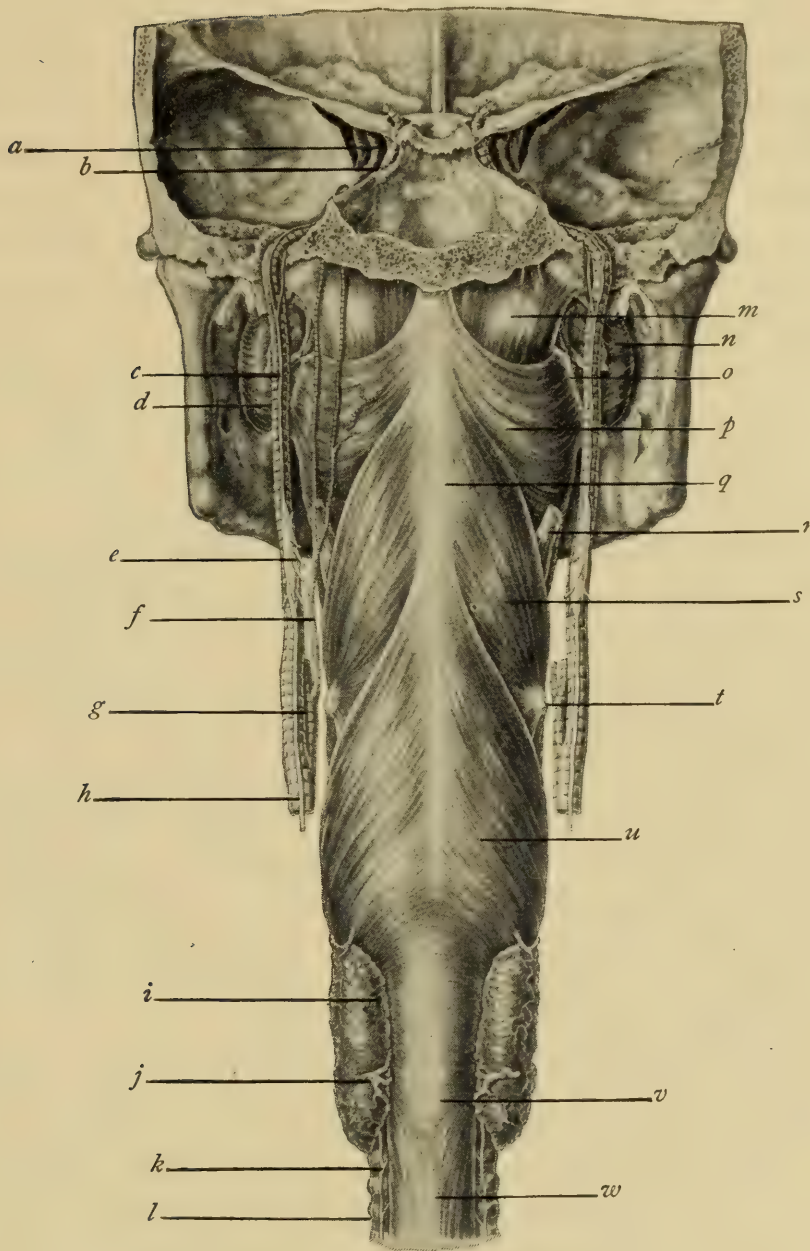


FIG. 81.—Constrictors of Pharynx. (Deaver.)

a, Ophthalmic artery; *b*, internal carotid artery; *c*, sympathetic nerve; *d*, internal carotid artery; *e*, superior cervical ganglion of sympathetic; *f*, ascending pharyngeal artery; *g*, external carotid artery; *h*, common carotid artery; *i*, lateral lobe of thyroid body; *j*, inferior thyroid artery; *k*, recurrent laryngeal nerve; *l*, trachea; *m*, pharyngeal aponeurosis and sinus of Morgagni; *n*, buccinator muscle; *o*, pterygomaxillary ligament; *p*, superior constrictor muscle; *q*, raphe; *r*, stylopharyngeus muscle; *s*, middle constrictor; *t*, greater cornu of hyoid bone; *u*, inferior constrictor; *v*, circular muscular fibers of esophagus; *w*, longitudinal muscular fibers of esophagus.

terior border of the thyroid cartilage near the base of the superior cornu and by a broad expansion into the fibrous layers of the pharynx at its lower part (Fig. 81).

The pharynx is separated from the vertebral column by the longus colli and rectus capitis antici muscles and by loose areolar tissue. Laterally it is in relation with the styloid process and its muscles, the glosso-pharyngeal nerve, the lateral lobes of the thyroid gland, the sheath of the carotid vessels, the pharyngeal plexus and the ascending pharyngeal artery.

In the vault of the pharynx at its middle portion just below the body of the occipital bone is a pouch called the "pharyngeal bursa." It is the persistent lower portion of the pharyngeal diverticulum, the "pouch of Rathke," and usually disappears in adult life.

Distributed over the wall of the rhinopharynx are numerous groups of lymphoid follicles comprising the "pharyngeal tonsil."

The muscles of the pharynx are supplied by the pharyngeal plexus and the external and recurrent laryngeal nerves. The stylo-pharyngeus is supplied by the glosso-pharyngeal nerve.

The pharynx is of unusual interest and importance since it is concerned in four functions, respiration, audition, phonation, and deglutition. As an example of the importance of a normal pharynx to the act of breathing and the function of the ears it is only necessary to refer to the morbid condition known as "adenoids" in the rhinopharynx, in which "mouth-breathing" and various aural disturbances are conspicuous.

Neoplastic growths, cicatricial contractions and malformations are met with in this region which may affect one or all of these functions. Aside from gross lesions it is necessary that the glandular apparatus of the pharyngeal mucosa should do its duty properly in order to furnish adequate lubrication for the lower pharynx in the act of swallowing. A resonant voice of pleasing quality can be produced only in the absence of deformity or anomalies in the pharyngeal wall.

The uvula with the velum assists the epiglottis in shutting off the buccal cavity in normal nasal respiration, and helps to close the nasopharynx during deglutition. It also directs the nasal secretions toward the glosso-epiglottic fossæ. When enlarged it frequently becomes a source of local or reflex irritation, while a considerable part of it may be sacrificed without detriment. On the other hand

paresis of the palatal muscles, or a cleft of the soft palate has a pronounced effect both on speech and swallowing.

The palatal or faucial tonsils are made up of a collection of follicles enclosing crypts or lacunæ, ten to twenty in number, lying between the palatal folds and resembling in structure Peyer's patches. Their function has been the subject of much speculation. They were once supposed to furnish a lubricant for the bolus of food and again to absorb from the saliva certain particles as a pabulum for leucocytes. In a normal state they are not visible. Whatever their function may be they would seem no longer capable of exercising it when hyperplastic and diseased. It has been shown that leucocytes may migrate from the lymphoid tissue into the lacunæ between the epithelial cells. Recent experiments have demonstrated that grains of carmin placed in the crypts appear later in the lymphoid tissue (Goodale). Similar absorption has been observed with various powders placed on the surface of the tonsils (Hendelsohn) and in the lower animals infection has followed rubbing the tonsillar surface with streptococci. The foreign particles were found to have passed not only between but through the epithelial cells, the conclusion of Stöhr that leucocytes pursue only the former course thus being opened to question. These experiments have a most important bearing on the conveyance of disease by infection, although they were conducted upon hypertrophied and therefore abnormal tonsils, and possibly throw no light on the function of normal lymphoid tissue. The latest investigations of this subject, with special reference to tuberculosis, show that the tonsils "as portals of infection" are no more susceptible than other portions of the mucous surface. In one hundred cases of pharyngeal tonsil examined by Rethi, six of tuberculosis were found. On the other hand, in more than two hundred specimens of lymphoid tissue examined microscopically and bacteriologically by Goruc not one showed a giant cell, a tuberculous nodule, or a tubercle bacillus. A similar result was obtained by Jonathan Wright in a series of 121 cases examined with that observer's well-known care and skill. Undoubtedly, however, tuberculous infection may take place by this route without involving the lymphoid tissue itself, and several interesting experiences suggest that a latent tuberculosis may be excited to activity by operative interference with hypertrophied lymphoid tissue in persons previously unsuspected (Lermoyez and

Chappell). Yet the occurrence of the latter is so rare as not to constitute a valid objection to operation in these cases. The study of the subject up to the present time does not indicate whether normal is more or less prone than morbid lymphoid tissue to absorb pathogenic germs. The resistance offered to bacterial invasion by the epithelium of a child's tonsil as well as of an acutely inflamed tonsil in the adult, must be very slight, yet a condition of hyperplasia and especially of fibrosis seems to impede absorption. In a case recently observed by the author suppuration of the cervical glands complicating a follicular amygdalitis was followed by suppression of urine and other signs of renal irritation, attributable to streptococcic infection. Such occurrences are not very uncommon and lend additional importance to simple inflammatory derangements of the pharyngeal structures. A case of primary tuberculoma of the nasopharynx recorded by Abercrombie is probably unique.

METHODS OF EXAMINATION.

The method of examining the rhinopharynx has already been described. Most of the oropharynx is within reach of the eye, yet even here a pharyngoscopic mirror is often useful. The probe is essential especially in examining pockets in the tonsillar region, and the index finger gives us valuable information as to the consistency of certain morbid growths and the mobility of neoplasms. Sharp-pointed foreign bodies often become engaged in the follicles at the base of the tongue or in the tonsillar crypts, where they may be detected by the finger when invisible to the eye. When the pharynx is very irritable, or the tongue arches and cannot be depressed by moderate force, a fair exposure of the parts may generally be obtained by directing the patient to take a deep inspiration and then sing a long "ah." Under ordinary conditions the walls of the laryngopharynx are in contact and are open to inspection only under the use of a dilating pharyngoscope. It has been proposed to examine the upper pharynx with the patient lying flat upon the back with the head well extended, the examiner standing at the head of the patient and introducing a large laryngeal mirror, the shank of which rests in the right angle of the patient's mouth instead of the left as usual. The awkwardness of the position and the satisfactory view generally obtained with the ordinary way of making an

examination of the upper pharynx will tend to prevent this method from becoming popular. Great advances have been made in our knowledge of the lower pharynx and esophagus as a result of studies by Mosher, Jackson, Killian and many others. At the present day these regions are brought directly under the eye for both explorative and operative purposes. In hypopharyngoscopy (von Eicken) the larynx is forcibly dragged away from the vertebral column by means of a stiff probe passed into or behind the cavity. The junction of the pharynx and esophagus, or "mouth of the esophagus" (Killian), is held firmly closed by muscular contraction and cannot be opened even by vigorous traction. At this point also the greatest resistance to the passage of a tube is encountered. A crescent-shaped lip or fold of mucous membrane at the entrance to the esophagus is described by Killian and is surmised, together with the peculiar muscular arrangement, to bear some relation to diverticula or pouches of the pharynx developing late in life.

CHAPTER XI.

DISEASES OF THE VELUM AND UVULA. BIFID UVULA. NEOPLASMS
AND MALIGNANT DISEASE OF THE VELUM. CLEFT PALATE.
UVULITIS AND ELONGATED UVULA. ACUTE AND CHRONIC
PHARYNGITIS. ATROPHIC PHARYNGITIS. RHEU-
MATIC PHARYNGITIS.

BIFID UVULA.

Bifurcation of the uvula is a very common congenital mal-development. It is an elementary palatal cleft. The two divisions of the uvula are often quite symmetrical (Fig. 82). The furrow rarely involves the muscular tissue. It seldom has any importance except when one of the segments is so placed as to cause cough by tickling the pharyngeal wall. In such cases, unless the tissues are extremely redundant, the two halves of the uvula may be united by denuding their opposed surfaces and bringing them together by means of one

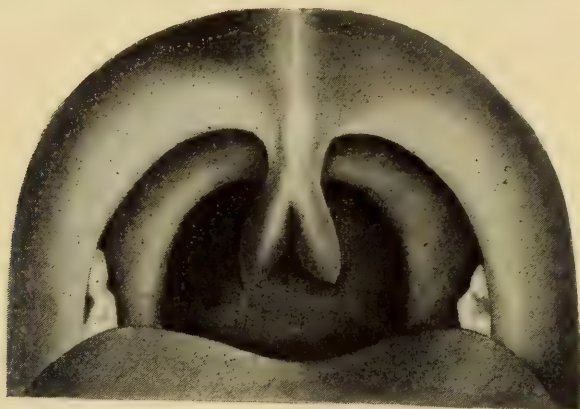


FIG. 82.—Bifid Uvula.

or more sutures, or if the tissues are in excess one or the other of the subdivisions may be excised.

Other malformations of the soft palate are sometimes seen, such as absence of the uvula or velum, asymmetry of the palatal arches, and perforations of one or both of the faucial pillars. Inequality of the sides of the palate may be congenital, independently of a paretic condition, while the latter is not infrequently observed

as a sequel of diphtheria or as a symptom of cerebral disease. Paralysis of the velum in non-diphtheritic nasopharyngitis of high intensity has been noted in several cases, among them one of my own, in which the loss of power persisted more than a month. Spasm of the velum, rhythmic or intermittent, may occur in connection with a general chorea, producing a distinctly audible sound, and more rarely in chronic rhinopharyngitis, causing what is described as "clicking tinnitus."

Neoplasms of the palate, with the exception of the small warty growths often seen at the margin of the velum, are rather rare, although this structure may suffer by invasion from other parts. No satisfactory cause can be assigned for the development of new growths in this region. In several instances a neoplasm supposed to be a papilloma has proved malignant. A few cases of fibroma, of lipoma, and of angioma of the velum have been reported. A case of cyst of the right posterior pillar has been recorded by Jonathan Wright. Adenoma is more frequent and is often combined with other morbid tissue. It usually occurs in adults and has been seen more often in women than in men. Nearly all these growths may be safely and readily removed with knife, scissors, or snare, although some deeply embedded tumors require considerable dissection. With angiomata a cutting operation should be avoided. In a case of the latter once under my care the electric cautery worked admirably. The simpler forms of these benign neoplasms grow very slowly if at all, produce no inconvenience and may properly be left alone.

Malignant disease appears in the form of sarcoma, or of carcinoma, the former, as in other situations, at almost any age, the latter usually in adult life. Owing to the scanty lymphatic circulation in this region glandular involvement is rather tardy. This fact combined with the relatively non-virulent tendency of sarcoma gives reason to hope for good results from early surgical intervention in this disease. All kinds of sarcomata are met with. Their growth is slow and painless until ulceration develops. The chief symptoms relate to the function of the palate. Finally deglutition becomes impeded, an ichorous discharge occurs from an ulcerated surface, and hemorrhage, even fatal, may take place. It is often difficult to differentiate this lesion from epithelioma and it is always necessary to exclude syphilis by progressive doses of iodide of potash.

Epithelioma is more common late in life and in the male sex. Its evolution is rapid and highly malignant. Pain is an early and prominent symptom. Ulceration with fetid discharge, hemorrhage and glandular infiltration follow in order. Cachexia is usually pronounced. Surgical interference offers little hope and the Coley method of injection with the toxins of the bacillus prodigiosus and of erysipelas, sometimes effective in sarcoma, is not available. Local anesthesia with cocaine, nirvanin, or orthoform, detergent washes and general anodynes comprise all the resources at our command.

Cleft palate and its appropriate treatment have been fertile topics for discussion many years. Space does not permit an exhaustive review of the subject, and in fact the condition is more apt to fall into the hands of the general surgeon than to the specialist. Suffice it to say that all shades of divergent opinion prevail with regard to its management, from one holding that mechanical correction of the defect is better than surgical intervention to the view that attempts at surgical closure should be undertaken in the earliest months of life. The technical details of uranoplasty seem to vary with the fancy of the operator. No less than twenty operations with slight variations bear the name of their respective promoters. Excessive tension on the flaps, disturbance of the wound especially by pressure from the tongue, and possibly septic infection have been recognized as interfering with the reparative process. The first is obviated by the formation of mucoperiosteal flaps by curved incisions in the hard palate along the alveolus on either side and by incisions carried well backward in the soft palate internal to the hamular process. An attempt to meet the last two difficulties is made in a method of operating in which a tracheotomy is done and after the cleft has been closed by sutures the oral cavity and the wound generally are firmly packed with sterilized gauze (J. F. McKernon). The trachea tube is retained for ten or twelve days, and the dressings are renewed each day, in the meantime feeding being carried on by the rectum. An objection to this plan from an aseptic standpoint appears in the fact that the salivary secretion is so stimulated that daily change of the dressings, with more or less disturbance of the wound, is necessary. The added risk of opening the trachea is not small and the irritation attendant upon a firm packing of the buccal and pharyngeal cavities is hardly compensated for by any improvement in results as compared with simpler modes of

operating. The prognosis as regards defective speech is better the younger the patient. In older persons of sensitive organization the moral effect of being relieved of a deformity of this kind is very considerable, irrespective of other benefits. Defective speech after closure of a palatal cleft is due in part to muscular atrophy and in part to tension of the velum which the muscles are too weak to overcome. With a view to improving these conditions Makuen proposes first division of adhesions between the pillars and the remnant of tonsils, second forcible stretching of the velum with the finger after division of tense fibers of the palatal muscles, and finally training and development of the palatal muscles by various direct and indirect voluntary exercises. Marked improvement has been observed in cases in which these procedures have been carried out, but it does not appear that perfectly normal speech is to be expected unless operative interference has been undertaken quite early in the formative speech period.

UVULITIS. ELONGATED UVULA.

Elongation of the uvula may result from frequent attacks of inflammation involving the velum as well as the pharyngeal structures. It causes sensations of tickling or of a foreign body in the pharynx, which may lead to a dry persistent cough aggravated while the patient is in a recumbent position. Asthmatic attacks and even alarming glottic spasm may be induced by a long uvula. In a voice user the condition is most important and requires immediate correction. In moderate cases astringents, such as nitrate of silver, or chromic acid, ten or twenty grains to the ounce, give relief. In some cases the general relaxed condition, due to anemia, should receive attention by the internal use of ferruginous preparations. In post-diphtheritic paralysis associated with a catarrhal condition, nerve tonics and electric applications are indicated, but no radical local treatment is required. Cases that resist these methods need surgical intervention and removal of the tip of the uvula, or staphylotomy must be done. Many instruments have been proposed, so-called uvulatomes, for this purpose, but it will be found quite as convenient to seize the tip of the uvula with the nasal forceps and remove as much as desired by means of the nasal scissors; the angle which these instruments possess carries the hands of the operator out of the

line of vision. Anesthria is obtained by the previous application of a 10 per cent. solution of cocaine. The tip of the uvula, being drawn somewhat forward, the line of incision is more or less oblique and the cut surface is thus made to look backward so that contact with food in swallowing is to some extent avoided. Bleeding is usually very slight and, in most cases, the pain of the operation and subsequent discomfort are not of much consequence. Now and then, however, bleeding is considerable and if not checked by astringent applications, requires to be controlled by a ligature, or the actual cautery, or as suggested by Carroll Morgan, by means of a clip like that attached to a garter.

With the electro-cautery loop the tip of the uvula may be removed bloodlessly, but less quickly than with the uvulatome. The stump is perhaps a little more sensitive after a burning than a cutting operation. Occasionally after a uvulotomy in neurotic subjects, severe neuralgic pain is experienced, but usually with care as to diet all reaction subsides in forty-eight hours. It is well not to include the muscular tissue of the uvula in the section. Yet almost complete extirpation of this appendage is now and then witnessed without apparent detriment to the function of the velum. In the method followed by Braden Kyle a wedge-shaped piece is removed by cutting obliquely downward on either side from the middle of the uvula. Thus the shape of the organ is preserved, provided the segments be stitched together, and the stump is less sensitive.

Acute uvulitis is generally an accompaniment of inflammation of adjacent structures or a pharyngitis. The uvula sometimes reaches the most extraordinary dimensions from edema, and in aggravated cases pain and obstruction to swallowing, or breathing, may be extreme. Multiple punctures of the swollen mass with a sharp-pointed bistoury permit the serum to drain off and encourage retraction. In moderate cases the effect of adrenal extract is said to be marvellous. Reference is made elsewhere to S. Solis-Cohen's extraordinary experience with an alarming edema of the velum following an application to the fauces of a suprarenal-chloretone solution. Such a phenomenon may be explained by a drug-idiosyncrasy on the part of the individual or perhaps by some peculiarity in the constitution of the medicinal preparation. It may be necessary to excise portions of the relaxed and edematous tissue in order to give relief. Recovery is expedited by spraying the fauces with a

solution of tannin, or alumnol, ten to twenty grains to the ounce of water. Astringent gargles, or lozenges, are sometimes useful.

Edema of the uvula, often without very acute inflammatory symptoms, may occur in the gouty or rheumatic and in those having some renal derangement. In all such cases the condition of the kidneys should be especially investigated.

ACUTE AND CHRONIC PHARYNGITIS.

The mucous membrane of the pharynx is subject to inflammatory changes similar to those occurring in the nasal cavities. The upper division of the pharynx, known as the rhinopharynx, is part of the air tract and here we find important pathological processes involving the lymphoid tissue as well as neoplastic formations of interest. In the middle portion of the pharynx diseased conditions are of two-fold importance for the reason that the oropharynx is part of the food tract as well as of the air tract; hence, lesions in this situation may affect swallowing as well as breathing. The third division of the pharynx, or laryngopharynx, begins at the level of the arytenoids and extends to the lower border of the cricoid, is a portion of the food tract only and rarely falls under the eye of the laryngologist except as disease reaches it from the laryngeal cavity. Foreign bodies may be detained or neoplasms may develop in this region and thence invade the laryngeal cavity, thus involving the functions of deglutition, phonation and respiration.

Inflammation of the pharyngeal mucosa may be acute or chronic. In the large majority of cases of so-called "cold-in-the-head" the prominent subjective symptom is a sensation of dryness referred to the region above the level of the soft palate. To the eye the surface appears dry, glazed and more or less swollen. This stage of inflammation resembles that occurring in other mucous membranes and the course of events is similar to that observed in the nasal cavities. The soft palate and pillars of the fauces are somewhat swollen and edematous. In the course of a few hours serous exudation begins and if the process is very intense rupture of capillaries occurs and the secretion is stained with blood. Finally it becomes thicker and more viscid, and if fibrinous elements predominate, as is apt to be the case in severe types of the disease, an exudate, or superficial false membrane forms resembling that of

diphtheria but not infectious. This condition is sometimes called "*membranous*" pharyngitis. If the inflammation extends beyond the limits of the rhinopharynx pain in swallowing is extreme, otherwise in cases of moderate severity there is nothing more than a feeling of fullness or uneasiness in the throat. There is constant desire to clear the throat and to swallow. The degree to which the voice and the senses of smell and hearing are affected depends upon the intensity and extent of the pharyngeal inflammation. There is usually some fever and general disturbance and the patient may really feel quite ill. The prognosis, in the absence of complications in the form of some organic or constitutional disease, is good, the parts resuming their previous condition in the course of a week or ten days. In many cases, however, a chronic catarrhal condition results.

The patient seldom attaches enough importance to his trouble to seek advice, so that we rarely see these cases early enough to do any good by efforts to abort the process. About all that can be done is to soothe the irritated parts by bland alkaline sprays followed by a protective coating of mentholized albolene, two to five grains of menthol to the ounce. Benzoinated steam inhalations are sometimes grateful. Attention should be given to a gouty or rheumatic diathesis, as well as to possible derangements of the gastrointestinal tract, and a brisk purgative is often indicated. If the sufferings of the patient are considerable codeine or some of the coal-tar products, as phenacetin with salol, may be used cautiously. Belladonna, in the familiar *rhinitis tablet*, is sometimes useful. The local use of astringents is not to be recommended as they merely aggravate the discomfort.

A very large proportion of *chronic* inflammatory conditions in this region are secondary to some lesion or deformity of the nasal chambers which first requires correction. A simple catarrhal pharyngitis sometimes yields to mild sedative or astringent applications which have been referred to in speaking of the therapeutics of rhinitis; in cases which prove more rebellious it is necessary to look for some etiological factor within the nose or in the accessory sinuses. In not a few cases too of chronic pharyngitis the cause must be sought in the digestive tract. Dyspeptics almost invariably present more or less of an index of their condition in the mucous membrane of the pharynx. Occasionally we meet with an inflammatory

condition involving chiefly the follicular elements of the pharyngeal mucous membrane constituting what is known as granular or follicular pharyngitis, or *clergyman's sore throat*, in which enlarged papillæ, or hyperplastic lymphoid nodules are distributed at intervals over the surface of the membrane. The temptation to remove these protuberances by means of the curette or destructive caustics should be resisted since, in many cases, the condition is symptomatic and radical measures directed to the local lesion encourage a tendency to atrophy of the mucous membrane and leave the patient more uncomfortable than he was originally. In some aggravated cases it is justifiable to touch the follicles with a chemical caustic, preferably trichloracetic acid, or the point of an electric cautery, care being taken to avoid making the application too extensive. On inspection of the fauces of certain individuals suffering from chronic pharyngitis there is seen in the middle of the pharyngeal wall an area of dry, glazed mucous membrane, dotted here and there with enlarged follicles and perhaps coated with a layer of tenacious secretion, and bounded on either side by a vertical band of red, thickened mucous membrane (Fig. 83). These lateral bands extend to the posterior pillars, which are themselves often much thickened, and they have been considered important enough to receive the independent title "pharyngitis hypertrophica lateralis." As a matter of fact they should always be looked upon as indicative of disease in the vault of the pharynx or in the nasal chambers. According to the histological researches of Cordes the bands consist of collections of lymphoid follicles embedded in a fibrous reticulum and are analogous in structure to the palatal tonsils and to adenoids in the pharyngeal vault. It is clear that the remedy for them is to be found in giving first attention to the morbid condition higher up in the air tract which acts as the exciting cause. Adventitious bands running from the Eustachian cushion to the lateral or posterior wall and remnants of lymphoid tissue occupying the fossa of Rosenmüller are often found and are best removed with the finger-nail or a small curette. The accumulation of secretion in the nasopharynx is sometimes a source of annoyance which may be relieved by irrigation of the parts by means of the postnasal syringe with warm alkaline solutions. Equal results are obtained in cases of irritable pharynx with more comfort to the patient from the use of a mentholized albolene spray through the anterior nares. Not infrequently

annoying aural complications result from blocking of the Eustachian tube. When the aural symptoms are purely congestive, they are relieved to some degree by mentholated spray or applications of suprarenal extract to the vault of the pharynx.

Inflammatory conditions in the nasopharynx are not infrequent complications or sequelæ of the exanthemata and in the latter case



FIG 83.—Chronic Follicular Pharyngitis and Hypertrophy of Lateral Bands.
(Grünwald.)

are benefited by general tonic treatment in combination with local applications. In all cases of "postnasal catarrh," especially of the class just mentioned, the possibility of sphenoidal or posterior ethmoidal disease as a source of the discharge should be investigated.

A chronic nasopharyngitis is perhaps the most annoying and frequent of the morbid conditions with which we meet. The victims of it are burdens to themselves and sources of disgust to their neighbors from the constant hawking and clearing efforts demanded by the tenacious secretions accumulated in the vault. There

is no doubt that many patients get into the habit of rasping their throats in this way quite unnecessarily. They should therefore be urged to resist the desire as far as possible. In the treatment of this condition our main reliance is on the selection of a suitable astringent so applied after careful cleansing as to reach the whole surface. In some cases, a postnasal application must be supplemented by one made through the anterior nares. Sulphocarbolate of zinc, 10 grains to the ounce, alumnol, 10 to 20 grains to the ounce, have, in my experience, proven the most agreeable and effective astringents. Nitrate of silver, 20 to 30 grains to the ounce, glycerol of tannin, or tincture of iodine, in cases of long standing in which the tissues are hyperplastic, may be more serviceable. These agents are best applied with a probe, the tip of which is bent at a right angle and wound with cotton. Once or twice a week is often enough for the stronger applications, the daily use of the milder solutions being continued in the intervals. The treatment should always be preceded by thorough cleansing of the parts with alkaline irrigations by means of the anterior douche or the postnasal syringe. For the aggravated cases more powerful applications are indicated. Bosworth recommends undiluted monochloroacetic acid and suggests lactic acid 30 to 60 grains to the ounce, or a guarded *porte-caustique* of his own device intended for fused chromic acid or nitrate of silver. These energetic measures are neither agreeable to the patient nor very efficacious, the authority just quoted admitting that results are unsatisfactory even from prolonged treatment. Internal medication has no specific effect but is often important in conditions of anemia, of gastrointestinal derangement, or in the gouty or rheumatic diathesis. Beverley Robinson speaks highly of cubebs internally with a view to rendering the mucous secretion more fluid and hence more easily disposed of. Alcohol except in very moderate quantities should be interdicted, and the use of tobacco, especially when the habit of inhaling the smoke is practised, should be restricted. The mode of life in general as to bathing, dress, exercise and diet must be supervised, but above all it is essential to remove an intranasal abnormality or obstruction which interferes with normal ventilation and drainage of the nasal tract. While excessive vigor in intranasal surgery is to be deprecated, it is surprising to what extent distressing subjective symptoms are relieved by removal of an

apparently unimportant nasal lesion. Such anomalies develop so gradually that the patient becomes accustomed to them and fails to appreciate their magnitude, whereas an equal degree of obstruction suddenly imposed would be intolerable. After all has been done a certain proportion, unfortunately a large one, of these cases continue to be annoyed by the "dropping" in the throat and by their morning clearing out process, and after going from one specialist to another and one climate to another with possible temporary improvement settle down to the conviction that they are incurable. Ultimately nature takes charge of the case and with advancing years more or less mitigation of symptoms is experienced.

ATROPHIC PHARYNGITIS.

Pharyngitis sicca, or atrophic pharyngitis, is the *result* of an inflammatory process induced by some local irritation, or is consecutive to a similar state in the nasal chambers. It may be associated with a constitutional condition characterized by malnutrition. The glandular secretion is perverted in quality and tends to adhere to the surface of the pharynx in dry scales or crusts, or as a thin film of inspissated mucus. On the other hand, sometimes the surface looks dry, thin and glazed, and has the appearance of having been varnished. The perverted secretion is itself a source of irritation and leads to connective tissue cell proliferation and eventually a contracting process takes place which obliterates the blood supply and destroys the secreting glands. A great variety of bacteria are found in the secretions but there is no evidence to prove that they are, in any degree, an etiological factor. A subjective sensation of dryness, accompanied by burning or itching and a desire to swallow, are the most prominent symptoms. There may be some difficulty in swallowing owing to deficient lubrication or to rigidity of the muscles. In most cases the dry secretions are very tough and adherent. The patient is annoyed by a constant desire to relieve himself by hawking and even this does not succeed in dislodging the mucus. When the secretions have been cleared off the membrane is obviously thinner than normal and is very apt to be somewhat mottled, in certain regions being congested, in others, pale. An unpleasant odor is imparted to the breath by the decomposing secretions.

The prognosis, as in atrophic rhinitis, depends upon the stage of advancement of the process.

No treatment will restore glands that have been destroyed. But, if the disease is attributable to certain local irritants which can be removed and if the atrophy has not progressed too far, the results of treatment are more encouraging. Any associated nasal deformity or disease must be removed. The first essential, as in similar nasal disorders, is perfect cleanliness, which must be secured at the outset by careful and thorough use of an alkaline wash followed by a mild degree of stimulation; the latter is attained by the application of solutions of ichthyol or formalin. For the cleansing process a post-nasal douche or syringe, and in exceptionally tolerant cases a coarse spray are effective. The stimulating applications should be used with caution and their strength must be determined for each individual. At the conclusion of treatment the parts should be protected by spraying with a solution of menthol in albolene, about 5 grains to the ounce. By patient perseverance in this course much may be accomplished even in apparently bad cases, at least as regards the relief of distressing symptoms. Electricity in the form of faradism has been found of benefit, the positive pole being in contact with the pharyngeal wall while the negative is held in the hand of the patient (Seiss). The current is applied for two or three minutes with advantage. Galvanism, used as in nasal atrophy is beneficial. Massage, by means of a mechanical vibrator, or by hand with a probe wound with cotton, is of service. If desired the cotton may be moistened with thymol, iodin, or carbolic acid in oily solution. Sometimes one agent and again another seems to act more satisfactorily.

Owing to occasional damage to the ears from the nasal douche its use is condemned by some, but with a bland alkaline detergent at proper temperature and if the patient is warned to let the fluid drain off gradually and not blow the nose violently with the nostrils compressed there is little or no danger.

Internally we might expect good results from drugs known to influence glandular secretion, such as jaborandi, pilocarpin, or the iodid salts. Occasionally they appear to give temporary relief by supplying moisture to the dry surfaces, but they cannot be long continued without danger of disturbing the stomach. Careful attention should be paid to the digestive function and if necessary

constipation should be corrected by the use of saline or other laxatives. Good hygiene and the general régime and treatment referred to in speaking of rhinitis are equally important in inflammation of the pharynx.

RHEUMATIC PHARYNGITIS.

The effects of the rheumatic diathesis upon the fibrous tissues of the pharyngeal wall are generally admitted but no definite local symptoms can be considered characteristic. Cases vary in their subjective phenomena and we have to rely on the general symptoms and on the rheumatic history in making a diagnosis. The general rheumatic disturbance, such as inflammation of muscles and joints, may not appear until after the pharyngeal symptoms have become established, or the latter may be secondary and insignificant. In most cases the local appearances are less intense than in ordinary acute pharyngitis and are abrupt in onset and disappearance. The pain in swallowing is out of proportion to the inflammatory appearances and is not influenced by the usual local remedies employed in simple tonsillitis or pharyngitis. It is usually met with at or after middle life and not infrequently follows exposure. Fatigue and depressed general health predispose to an attack. Relapses are frequent and it is noticed that outbreaks of the affection are common in the spring and fall of the year or after a decided fall of temperature.

Local treatment is of little avail, although the application of heat, externally and by steam inhalations, is sometimes grateful. Cases usually respond as soon as the system is under the influence of anti-rheumatic medication. The salicylates, especially the salicylate of sodium in ten-grain doses every four hours, give the most satisfaction. If not well tolerated aspirin, or novaspirin, is preferable. Some cases seem to act better under the alkaline treatment, small doses of bicarbonate of soda, of sodium phosphate, or of Rochelle or Carlsbad salts being administered at short intervals.

While it seems to be established that a very large proportion, according to St. Clair Thomson from 30 to 38 per cent., of cases of acute rheumatism begin with an angina, yet the local pharyngeal indications are indefinite. Apparently the parenchymatous or follicular form of amygdalitis, rather than the phlegmonous,

or quinsy, is the rheumatic type. At any rate antirheumatic remedies are often effective in the former and are much less so in the latter. Possibly the rheumatic virus may enter the system by way of the pharynx, as is the case with other poisons, and leave no local indications.

CHAPTER XII

ADENOIDS IN THE RHINOPHARYNX.

The name tonsil has been applied to various collections of lymphoid tissue beside those between the palatal folds; at the base of the tongue is the *lingual* tonsil; in the vault of the pharynx the *pharyngeal* tonsil; in addition, small masses in or near the ventricles of the larynx are called the *laryngeal* tonsils; and of still less importance the aggregations within the nostrils are known as the *nasal* tonsils.

The collection in the vault of the pharynx, the pharyngeal tonsil, or *adenoids*, is perhaps the most important. It is a conglomerate gland, covered by thin mucous membrane and columnar epithelium, sometimes ciliated. It is a vascular body and, like the faucial tonsil, is a *normal* organ which is disposed to undergo atrophy at about maturity. The idea that tonsils are normal bodies is vigorously combated by Bosworth, who contends that a visible tonsil is an abnormality and should be removed like any other tumor. No one at the present day is likely to affirm that an organ is "normal" which is itself diseased or may be the cause of morbid conditions elsewhere, yet it is often equally difficult to define the boundary between a normal and an abnormal tonsil and to decide whether in a given case a mass of lymphoid tissue needs to be removed. Many diseased tonsils are carried through life without detriment and the latter question hinges mainly on the degree of subjective disturbance they excite rather than on their dimensions or degree of abnormality. Nodules of lymphoid tissue are undoubtedly normal in certain regions. Perhaps we may admit the correctness of the view that "the tonsils are pathological entities when they can be demonstrated clinically," but that is very different from saying that all tonsils should be removed. The points to be determined are, first, whether the enlarged lymph nodes have ceased to perform their function, presumably that of defending the system against infectious germs, and, second, whether they are a cause of local or general derangement.

The pharyngeal tonsil has been particularly described by the

German anatomist Luschka and is sometimes called "Luschka's bursa or tonsil," this name being restricted to the main aggregation of lymphoid tissue in the middle of the pharyngeal vault. A large crypt or lacuna in the midst of this bursa often ends in a dilated extremity which sometimes becomes distended by accumulation of secretion owing to obstruction of its outlet, thus forming a cyst of considerable dimensions which occasionally undergoes suppuration. It has been particularly studied by Tornwaldt and from him is known

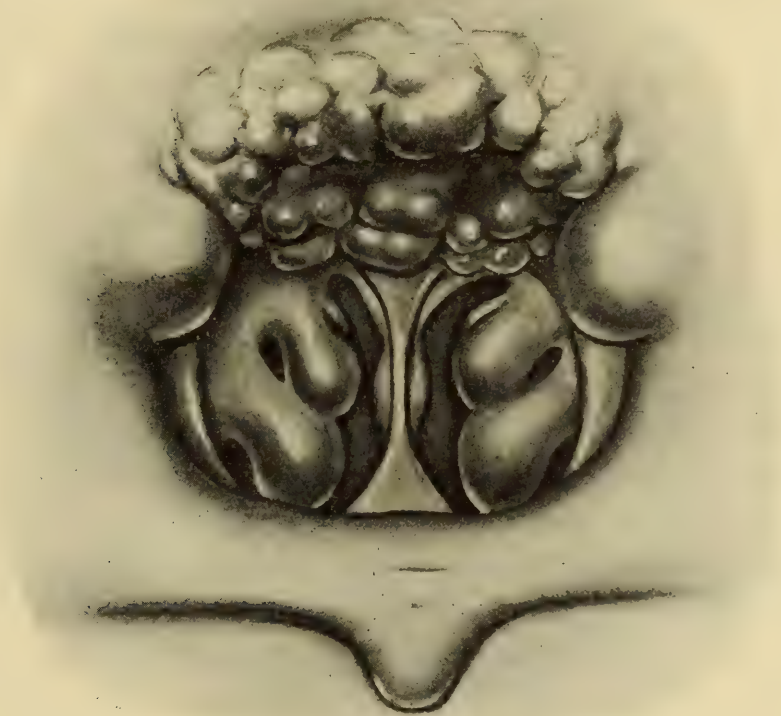


FIG. 84.—Adenoids in Rhinopharynx. (*Grünwald.*)

as Tornwaldt's disease, or cyst of the pharyngeal bursa. The pharyngeal tonsil, or adenoid vegetations, becomes of interest and importance in its enlarged condition from the obstruction it offers to nasal respiration, from disturbance it may excite in the ear by pressure in the region of the Eustachian tube or orifice, and from the causative relation it bears to various other disorders, reflex derangements as well as infectious diseases (Fig. 84).

Adenoids are met with very early in life, if they are not actually congenital. They are always an impediment to health and in a

nursing infant may be a serious obstacle to nutrition. They are seldom seen in adults, although several marked examples in very old subjects have been recorded. Remnants of lymphoid tissue and the evidences of the damage it has done are frequently recognized in elderly people.

The cause of this morbid condition is not always discoverable, but it is evidently a frequent sequel of the exanthemata in children and, in a large proportion of cases, is associated with a general dryscrasia resembling struma which has been described by Potain under the name *lymphatism*.

The subject of the condition, when it exists in a marked degree, presents a facial expression which is in a measure pathognomonic. If a child he goes about with open mouth and a very dull countenance, the eyes are heavy and stupid, the external nose is rather small and undeveloped and the upper lip is thick and prominent. Effacement of the naso-labial furrow and distention of the transverse nasal vein are often noticeable. The palatal arch is usually high, narrow and V-shaped, and the upper jaw tends to protrude. Nasal breathing, through the day, may be natural or impeded, but at night respiration is noisy and labored. The child frequently awakens from sleep suddenly as though startled by troubled dreams. The voice has a peculiar quality called the "dead voice" in which there is decided lack of resonance. Hearing is generally impaired and the patient has frequent attacks of earache. Nose-bleed is a common symptom and, in children, should always excite suspicion of the existence of adenoids. A purulent discharge from the nostrils, often producing excoriation and eczema of the upper lip, is very common. Frequently the patient is disturbed by hacking cough, paroxysmal in character, or actual attacks of laryngismus may be induced. Asthma, chorea, enuresis and prolapse of the rectum are some of the ills attributed with more or less reason to adenoids. Deformity of the chest wall, "pigeon breast," is referred by some to labored respiration caused by the clogging up of the postnasal space. Probably the thoracic deformity is due quite as much to the depraved systemic condition as to the mechanical obstruction to breathing. We find many cases occurring in the same family, whether attributable to heredity or to the fact that the patients are all in a similar environment is not determined. Climatic and atmospheric conditions play an important part in the develop-

ment of the lesion. Dampness, bad air and unsanitary surroundings certainly predispose to it. Enlargement is not always due to hyperplasia or increased connective tissue but may be a simple temporary turgescence; consequently it is not unusual to see extreme changes in the dimensions of the adenoid mass. When it has been subjected to repeated attacks of acute or subacute inflammation more or less permanent thickening results. Lennox Browne suggests a relationship between adenoid vegetations and laryngeal neoplasms in children from the fact that the former are "responsible for much infantile laryngitis," a condition doubtless predisposing to neoplastic formation. He refers to cases of dyspnea after removal of a tracheal canula in diphtheria relieved by ablation of adenoids (Martha) in confirmation of his opinion that excision of tonsils and adenoids is advisable even in an acute stage of diphtheria as a means of averting the necessity of a tracheotomy. The propriety of eliminating morbid conditions in the upper air tract in new growths of the larynx cannot be questioned, yet the proportion of the latter to hypertrophied tonsils and adenoids is so small that an etiological connection is very doubtful. In the light of the present improved therapeutics of diphtheria the radical disposal of enlarged tonsils in the course of that disease as proposed will hardly meet with general favor.

From a pathological standpoint four varieties of adenoid growths have been described (Kyle). First, a soft, diffuse, friable mass, composed mostly of lymphoid tissue and covered with a thin layer of epithelium. Second, an edematous, or cyanotic, form in which the gland tissue is but slightly increased, the enlargement resulting rather from venous stasis and edema. It is apt to occur in children affected by some intestinal irritation or circulatory disturbance. Third, a hard variety in which there is decided increase of connective tissue as well as of lymphatic elements. Fourth, also a hard form caused by repeated attacks of acute or subacute inflammation followed by organization of connective tissue and moderate contraction. It is usually secondary to intranasal disease.

For practical purposes a division into soft and hard meets all requirements. It is quite probable that many adenoid cases are needlessly subjected to operative interference, owing to lack of appreciation of the fact that in some children these lymphoid structures are very sensitive to external impressions and systemic derangements.

They are prone to temporary turgescence or inflammation, when many of the subjective symptoms caused by established lymphoid hyperplasia or by an acute inflammatory process are exhibited. Preparations may be made to operate on a case of this kind and when the time comes little or nothing is found to be attacked.

The *symptoms* of adenoids vary with the degree of their development and the relative dimensions of the nasopharynx. A moderate mass in a contracted pharynx may create grave disturbance, while a large volume is carried in a capacious pharynx without much complaint. The temperament of the patient also has a bearing on the subjective symptoms. In a nervous impressionable child the general perturbation is more marked than in one of phlegmatic disposition. As already suggested the symptoms refer primarily to the functions of respiration and audition. A very large proportion of cases of impaired hearing in adults may be traced to neglected adenoids in childhood. A very curious condition of mental lethargy denominated *aproxexia* (Guye), marked chiefly by inability to concentrate the attention, is clearly referable to this condition. Children previously stupid and backward frequently gain average intelligence after having been relieved of their impediments. The dullness in these children is explained in part by impairment of hearing and in part by the obstruction to the cerebral lymphatic circulation. An interesting example of this condition reported by Jonathan Wright occurred in a boy of fifteen who complained that "he could not remember or fix his mind on his tasks." Two or three minutes after a digital examination, which revealed a considerable collection of adenoids, he fell in a slight convulsion lasting less than a minute. On recovery he appeared dazed and stupid for some moments and was impressed by the belief that he had been given an electric shock. This and a similar case are looked upon as instances of nasopharyngeal reflex as well as of *aproxexia*, the former assumption being less well founded than the latter. Care should be taken not to confound the shock and faintness attendant upon an examination like that made in these cases, and especially apt to occur in children of the adenoid class displaying the neurotic disposition, with a true reflex. There is an unmistakable impression upon the general health as a result of the restlessness at night caused by mouth breathing. The obstacle to respiration is aggravated by the increase of blood in the parts in a recumbent position and by the muscular relaxation occur-

ring in sleep. In most cases the faucial tonsils are also hypertrophied and drag the tongue back over the larynx in such a way as to still further constrict the air channel. A peculiar change in the quality of the voice is almost invariable, but frequently in addition there is a faulty enunciation of some of the consonants, or actual stuttering results. Frequently the glands at the angle of the jaw or in the lower cervical triangle are enlarged. The sense of taste is impaired or lost from dry mouth. The act of swallowing is interfered with, and not infrequently food is regurgitated into the nasopharynx from relaxation of the soft palate.

The diagnosis is seldom difficult; usually the facial expression is characteristic and the condition may be surmised at a glance. Attention has been directed to the fact that the so-called "adenoid facies" is simulated in certain conditions of nasal obstruction and may be quite pronounced when no adenoids whatever are present, and on the contrary some cases of extreme lymphoid hyperplasia do not exhibit the typical physiognomy. The following are enumerated by Chappell among the conditions causing respiratory stenosis resembling that due to adenoids. Most of them are peculiar to early life and several are so rare as to be unworthy of consideration. (1) Lymphatism and lithemia, (2) syphilitic and gonorrheal rhinitis, (3) congenital occlusion of the nares, (4) digestive disturbances, (5) congenitally high arched palate, (6) small or occluded nostril, (7) unusually small postnasal space, (8) anterior projection of the bodies of the cervical vertebræ, (9) some malformations of the soft palate, (10) hypertrophy of the tongue. Natier insists that in certain neurotic children a state of "false adenoidism" sometimes exists which is corrected by attention to the general health and by the use of methodical breathing exercises. It would appear, therefore, that a positive opinion cannot be safely based upon suspicious appearances. The rhinoscope, or the finger, must be used in every case. In young children pharyngoscopic examination is difficult, yet with a little patience a satisfactory view is obtained even in unpromising subjects. Digital examination gives us infallible testimony. It is not very agreeable to the patient but is done with celerity and safety in a way elsewhere described (p. 17). The sensation conveyed to the finger by a mass of adenoids is unmistakable. It has been likened to that of a bunch of "earth worms." The soft form of adenoids is elastic, compressible, lobulated and vascular, so that the examining finger

on its withdrawal is stained with blood even though but little force has been used. The hard variety is more resistant and smoother as well as less vascular. If a rhinoscopic view is possible the arches of the choanæ are seen to be obscured by pendulous masses hanging from the vault and often invading the posterior nares. The view obtained in the mirror is very deceptive and should not be relied upon in estimating the quantity of adenoid vegetations in a given case. An opinion as to treatment must be based upon the history of the case and the information gained by exploring with the finger (Fig. 85).

The *prognosis* is good provided the condition be recognized early and the adenoids thoroughly removed. If allowed to remain with

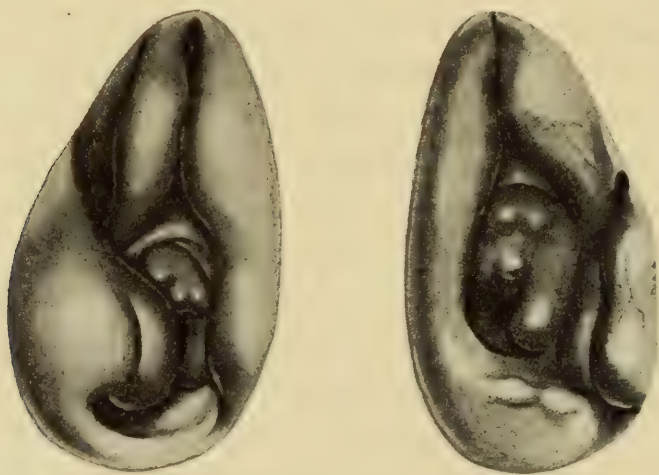


FIG. 85.—Adenoids in Vault of Pharynx Seen Through Dilated Anterior Nares. (Grünwald.)

the hope of the occurrence of atrophy, associated derangements, as for example in the ears, may progress to an irremediable degree. In the hard variety of adenoids there is no use in wasting time over local applications or in an endeavor to improve the general condition of the patient. The depraved general state is so clearly aggravated by, if not the direct result of, the local condition that the latter demands first attention. Engorgement of the adenoid mass due to inflammatory or intestinal disturbance is relieved by appropriate treatment and does not require the radical interference demanded in established disease. In the soft variety and in very young children when the symptoms have not long existed removal of the mass by simply scraping with the index finger frequently suffices. In infants of two years and under this is readily done without an anesthe-

tic, attention being paid as far as possible to asepsis by preliminary cleansing of the hands of the operator and of the nasopharynx with a saturated boric acid solution. In these cases and when an anesthetic is used the jaws must be held apart with a mouth gag (Fig. 86).

In older children in whom obstructive symptoms are persistent it is a better plan to remove the growths thoroughly under ether or other anesthetic. Thus the shock of the operation is less and opportunity is given for deliberate and careful exploration and, consequently, more thorough removal.

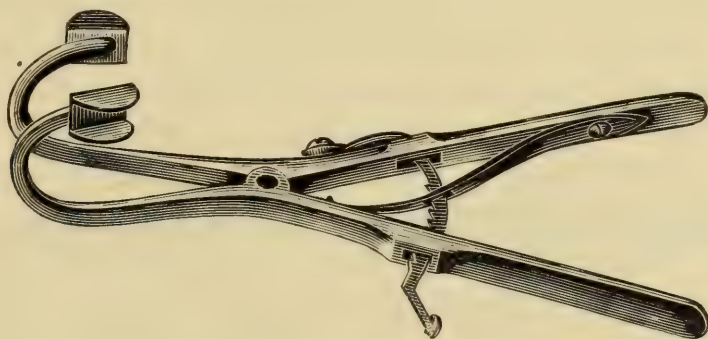


FIG. 86.—Denhard's Mouth-Gag.

Contrary to the generally received opinion that chloroform is a safe anesthetic in children T. H. Halsted maintains with much reason that the lymphatic diathesis especially favors the depressing effect of chloroform upon the heart. This observer prefers ether, and to mitigate its suffocative effects and the after nausea he recommends the instillation into the nares of two or three drops of a 5 or 10 per cent. solution of cocaine. Many operators rely upon chloroform at all ages, in spite of the fact that it is less safe than ether. The indiscriminate use of cocaine is unwise, yet it seems to be clearly established that reflex respiratory inhibition may be prevented by an application of a 2 per cent. solution of cocaine. According to George Crile a much weaker solution, even a 0.5 per cent., is effectual. It is well known that atropine prevents cardiac inhibition. This observer goes so far as to advise in operations in this region a preliminary application of cocaine or eucaine and a hypodermic of atropine. With the mode of anesthetization presently to be recommended the employment of these drugs is entirely unnecessary. The statement is made by James Ewing that about fifteen deaths from chloroform in lymphoid cases have come to his knowledge

and the conviction is growing that chloroform is especially fatal in cases of this class. In the face of all the adverse testimony its continued use should not be countenanced.

The number of casualties under general anesthesia has reached so large a total, very many cases never having been reported, that we are called upon to exercise the utmost care and intelligence in the administration of whatever anesthetic may be selected. So far as possible all contraindications should be eliminated and the actual responsibility of giving it should be entrusted only to an expert. The observation and experience of F. W. Hinkel fully corroborate the views just expressed and justify the conviction that chloroform should never be used in these cases. Its advantages by no means outweigh its perils and should not be considered in the presence of other anesthetics relatively safe and equally effective.

Ethyl bromide and ethyl chloride are used more or less, but have their dangers. The tendency of the latter to increase the coagulability of the blood and thus favor the occurrence of pulmonary embolism has been pointed out by Mennell. A rather strong case is made for the chloride by the report of the London Throat and Ear Hospital by Kingsford. In 11,723 administrations there were no fatalities and only six occasions when there was reason for serious anxiety on account of suspension of breathing. Great care should be employed in the manufacture of ethyl bromide. It is possible that some of the accidents attending its administration and consequent prejudice against it may be due to the use of an impure product. Eman and De Roaldes, whose experience with it has been extensive and favorable, lay stress on this particular. It should be given to a patient only in the recumbent position, and unconsciousness is induced rapidly by giving 5 to 10 grams of ethyl bromide *before* chloroform or ether. Schmidt mentions the occurrence of death in five cases under ethyl bromide presumably due to cardiac weakness. On the other hand, Gleitsmann, who formerly preferred the well-known A.C.E. mixture, has used ethyl bromide in many hundred cases without an accident. Emil Mayer has had excellent satisfaction with the Schleich mixture, of which about 4 drachms is sufficient to produce complete narcosis in four to six minutes, and recovery is equally rapid, but his confidence in this combination is not generally shared because of the notoriously unequal volatility of its ingredients.

It is improbable that general agreement will ever be reached as to the kind of anesthetic desirable, or even as to the necessity of any anesthetic. It is the custom with many general practitioners to scrape the vault of the pharynx of very young children with the finger-nail, but this is far from being an aseptic or an effective instrument. This method without anesthesia may answer in clinics, but will not do in private practice, if we wish to retain the trust and good will of our little patients. A vigorous opponent of anesthesia appears in H. Gradle, who has designed a special adenotome, modified from one proposed by Schuetz (Fig. 87). The size and curve of the instrument are such as to fit any pharynx above the



FIG. 87.—Schuetz's Adenotome.

fourth year, and in rather a large experience he has found it invariably capable of removing all the growth with much less hemorrhage than after any other mode of operating. Its action is quick and relatively painless, and there is less shock and less risk than with any instrument under general anesthesia. The latter this observer condemns, *except* in unmanageable children, or when the faucial tonsils are to be removed at the same time.

The method of giving ether elaborated by Fillebrown and Rogers is sometimes recommended, but is more especially useful in long operations in which it is important that the manipulations of the surgeon should not be interfered with. In their apparatus ether vapor is forced through a tube to the patient's face by means of a bellows worked by the foot.

My own preference is strongly in favor of the use of nitrous oxide gas, followed by ether, as being decidedly the safest and most expeditious mode of procedure. The danger of anesthesia is thus reduced to the lowest possible degree and the operation itself is much expedited by preliminary use of nitrous oxide. Gas alone is

too transient. In very young children the drop method of etherization is most satisfactory.

All danger of asphyxiation from inspiration of foreign matter is obviated by placing the patient in Rose's position with the head dependent over the end of the operating table so that blood clots and débris accumulate in the pharynx rather than gravitate toward the larynx. The upright position in operating was preferred by the late F. H. Hooper, who was among the first in this country to realize the serious importance of adenoid hypertrophy. His contributions to the literature of the subject and his suggestions as to operative technic possess a permanent value. His views as to position in this as well as in other operations in the upper air tract have some advocates at the present day, among them T. R. French, who has devised a chair to which the patient is strapped after partial anesthesia in a horizontal position. In order to avoid disturbance of circulation and cerebral anemia the patient must be very slowly raised to a sitting posture. The advantages claimed are first, marked reduction in amount of blood lost, second, lessened chance of ear complications owing to thorough drainage of blood from the rhinopharynx, third, retention of the usual relationship between operator and patient, whereby the operation is much facilitated. In certain cases loss of blood may be a matter of some consequence, but as a rule hemorrhage in adenectomy is inconsiderable. Great stress is laid upon danger to the ears from retention of blood clots about the Eustachian orifices, which seems to me more fancied than real in the light of my experience with the recumbent position without a single case of ear complication. There is some force in the statement that operations with the head dependent are more awkward and difficult than when it is upright in a position to which we are accustomed in everyday work. This would be more generally admissible, but for the fact that the operation for adenoids is usually done without the aid of the sense of sight.

In the early periods operative procedures, as practised and recommended by Meyer, of Copenhagen, whose name has been made illustrious by his invaluable researches of this subject, consisted of removal of these growths by the sharp curette, or ring knife, passed through the anterior naris and guided by the finger introduced behind the velum (Fig. 88). It soon became apparent that they could be more easily reached through the mouth and various postnasal for-

ceps have been devised for the purpose. Those first used were intended for avulsion (Fig. 89) but in attempting to tear the growth from its site there is danger of stripping up the mucous membrane so that cutting instruments are now preferred (Fig. 90). The blades of the forceps in use to-day are much larger than those orig-



FIG. 88.—Meyer's Ring Knife.

inally employed with the object of enabling us to do the operation more rapidly. It is a good plan to have a variety of forceps and curettes, some to cut anteroposteriorly and some laterally (Fig. 91). The forefinger or steel finger nail as recommended by Dalby or Motaïs (Fig. 92), with the Gottstein curette (Fig. 94) and the

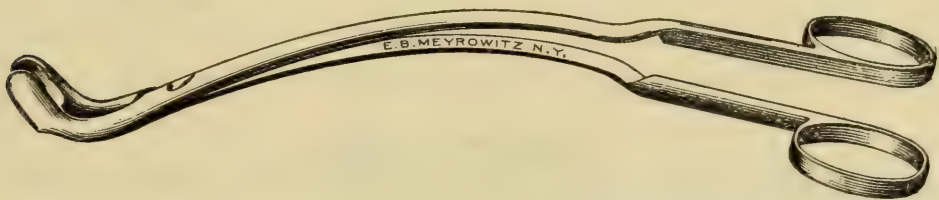


FIG. 89.—Loewenberg's Adenoid Forceps.

large-bladed forceps of the author (Fig. 96) comprise the instruments capable of meeting all possible contingencies. Many operators express strong preference for the cold wire snare to be introduced through the nostril or by means of a curved canula behind the velum. The use of Ingal's nasal cutting forceps some-



FIG. 90.—Brandegee's Adenoid Forceps.

what modified has recently been strongly advocated by Otto Freer. (Fig. 93). In rare cases in which the patient refuses to submit to the knife or in which we apprehend hemorrhage the galvano-cautery may be resorted to, applied under the guidance of the mirror behind the velum with the aid of the palate hook, the parts having

been thoroughly cocainized. We endeavor in every case to remove or destroy the tissue as thoroughly as possible, and after the forceps

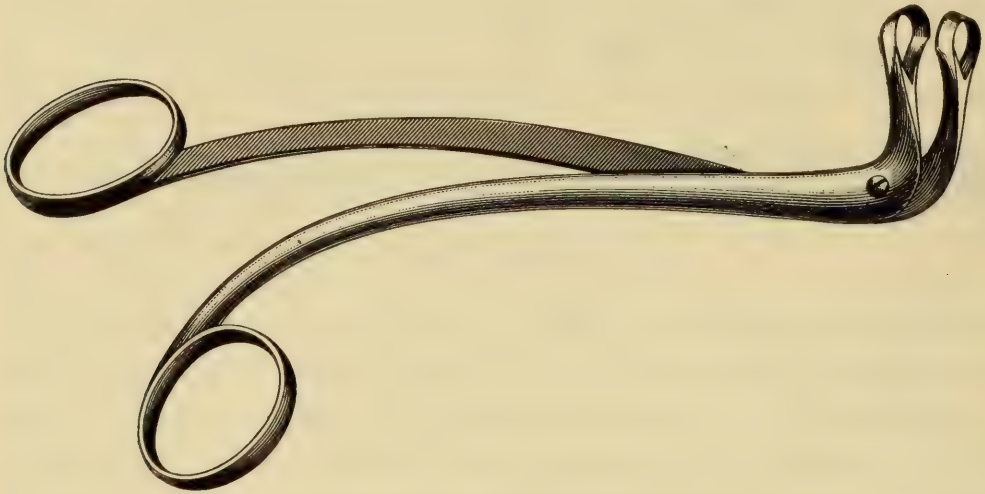


FIG. 91.—Schuetz's Anteroposterior Forceps.

and curette have been employed the parts should be explored for possible remnants or tabs of adenoid tissue still requiring attention.

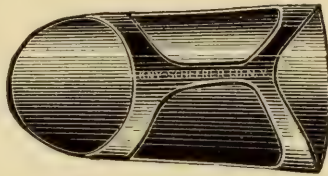


FIG. 92.—Motais' Artificial Finger Nail.

The after-treatment consists simply in keeping the patient at rest. It is unwise and unnecessary to disturb him by any application or

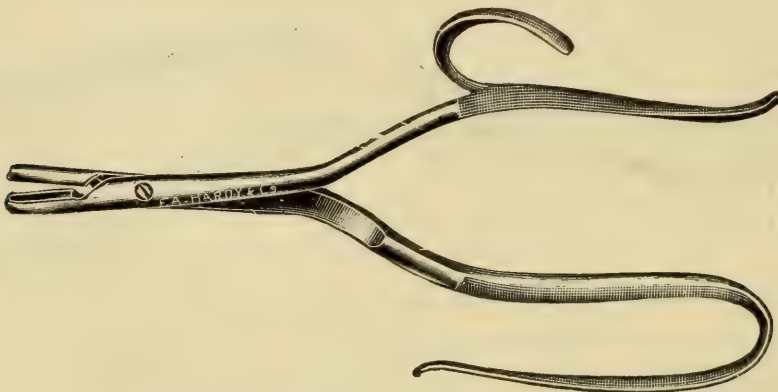


FIG. 93.—Freer's Pernasal Adenoid Forceps.

douching; the drainage in this region is so perfect that indications of septic infection are almost unheard of. Attention has been

drawn by C. G. Kerley to the occurrence of adhesions after adenectomy. He maintains that it is frequent and should be obviated by passing the finger into the vault of the pharynx at intervals during convalescence. A number of cases of hemorrhage and several of fatal bleeding after removal of adenoids have been reported by



FIG. 94.—Gottstein's Adenoid Curette.

J. E. Newcomb and others, and serve to impress upon us the importance of securing the history of all cases before operation as well as of careful attention afterward. Children should not be permitted to sleep continuously for several hours; they should be watched for any irregularity in the circulation. Should there

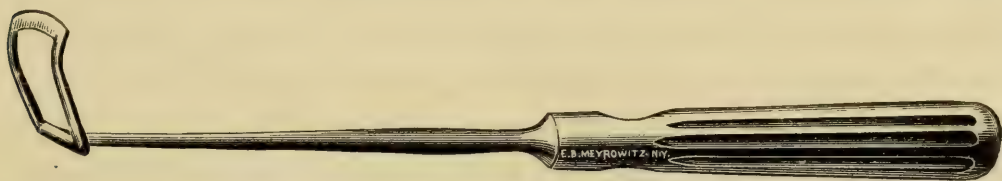


FIG. 95.—Beckmann's Curette.

be signs of persistent bleeding, after failure of attempt to check it by means of astringent irrigations of alum or tannogallic acid, the naso-pharynx should be firmly packed with gauze passed in through the mouth; or the plugging is accomplished as in epistaxis.

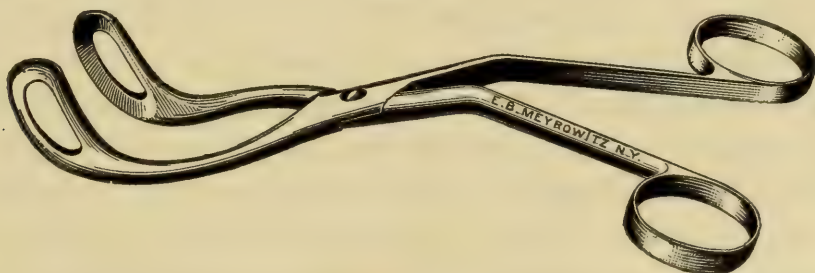


FIG. 96.—Author's Adenoid Forceps.

A combination of an alcoholic solution of tannin and antipyrin as a hemostatic was hit upon accidentally by Roswell Park, who speaks enthusiastically of its efficacy in a case of hemorrhage after removal of adenoids by F. W. Hinkel, as well as in bleeding in other situations. It forms a gummy adhesive mass which clings closely to

the part to which it is applied and makes a firm impenetrable tampon. The difficulty in removing it is the main objection to it, perhaps a minor one in general, but which applies to all tampons in cases of hemophilia. This point is very strikingly illustrated in cases described by A. A. Bliss. One of these, a case of deviated septum and adenoids, resulted fatally on the fourth day, recurrence of bleeding taking place on the slightest attempt to disturb the tampon. The obvious lesson is that all operative cases should be carefully investigated beforehand for the possible existence of hemorrhagic diathesis. It is a strange fact that some of the victims of hemophilia underestimate, or exhibit a moral perversity which leads them to conceal, their weakness, and our first intimation of its existence may be the occurrence of bleeding after operation. It is probable that in the product of the suprarenal gland we have an antidote to this condition more reliable than any hitherto possessed, but the fact remains that cutting operations in bleeders are better avoided. The administration of calcium chloride or lactate as a prophylactic as well as for the control of hemorrhage is of apparent value.

In the use of cutting instruments in the post-nasal space certain accidents may occur which may be obviated by the exercise of ordinary care. First, the margin of the velum may be lacerated by the blade of the forceps unless the instrument be passed well into the vault of the pharynx before being opened, the palate meanwhile being dragged forward by means of the left forefinger hooked behind it. Second, the edge of the vomer may be nicked if the handle of the forceps be too much depressed, not a serious matter but as well omitted. Third, the Eustachian cushion may be bruised or cut by carelessly tilting the instrument too much to one or the other side. Finally, a considerable flap of mucous membrane may be stripped from the posterior wall of the pharynx, which may be prevented by ploughing up the lymphoid tissue from below with the finger nail before applying the forceps, or by pressure with the finger tip at the lower limit of the adenoid mass while it is being torn from its attachments. While these incidents are usually of minor importance, on the other hand they may become somewhat embarrassing complications and prolong convalescence.

Inflammation of the middle ear is an occasional sequel of adenectomy and is most liable to occur in those who have already suffered from aural complications. Children who have had otorrhea, or

been subject to earache, should receive special attention as regards precaution against exposure after operation. A curious phenomenon has been observed in several cases after removal of lymphoid hyperplasia, referable to excessive energy in the use of the curette or forceps, or to some peculiar neurotic state of the patient, namely torticollis, a complication developing two or three days after operation and subsiding in the course of a week as the wound gradually heals.

The question is often asked as to the probability of relief of symptoms and of recurrence after removal of adenoids. In a large proportion of cases the relief is immediate and marked. Patients who have previously disturbed the household by noisy breathing at night will sleep so tranquilly as to excite the alarm of anxious parents. In certain individuals, however, in whom the habit of mouth breathing is firmly established and in whom, also, the parts are ill developed from prolonged disuse, nasal respiration is not immediately free. Under these circumstances we are sometimes obliged to resort to measures for closing the mouth during sleep and aiding the patient to learn the use of the nose for breathing. A shield worn within the lips or simply binding up the chin generally answers the purpose. Recurrence of adenoids may take place, even after thorough removal, especially when the operation has been performed early in life, in children of pronounced lymphatic tendencies. In many, however, it must be admitted that relapse is due to incompleteness of the operation, or to a coexistent obstruction within the nasal cavities. The last mentioned factor is of the utmost importance and in all cases of adenoids at any period of life nasal stenosis which is always productive of a state of hyperemia and favors the reformation of lymphoid tissue should be remedied.

In older children and adults general anesthesia is not requisite. With cocaine and a large curette the operation may be done at one sitting. Most patients consider this preferable to frequent repetitions of a performance always uncomfortable and often painful. In manageable subjects the forceps is used with the aid of a palate hook and under the guidance of the mirror. This is the most satisfactory and precise mode of operating, but is seldom found to be applicable, and we are compelled to rely upon the tactile sense in determining the character and distribution of the vegetations. The fossæ of Rosenmüller as regards the ears, and the choanæ, as regards

breathing, are critical situations and are most effectively and safely reached with the forefinger, or, in case the operative field can be seen, with a small curette. Neglect of the latter region is a prominent cause of failure in the operation. Masses of lymphoid tissue may be crowded into the nares by the forceps or curette, or may be actually attached at some point anterior to the choanæ. Hence the suggestion of Ingals to clear out the posterior nares by means of nasal cutting forceps passed from the front is valuable. Or a small ring knife may be of service in this situation. In any case to give the best results the operation must be thorough, every vestige of morbid tissue being sought for and removed. No doubt it is possible for anyone to pass a curette into the nasopharynx and scrape away more or less tissue, but this is not adenectomy as it should be done and tends rather to bring the operation into disrepute owing to incomplete relief and recurrence of symptoms. Properly done there is no procedure in the domain of rhinology more prompt and satisfactory in its effects.

CHAPTER XIII.

HYPERTROPHIED TONSILS.

Hypertrophied tonsils appear in two forms: the hard or fibrous tonsil which results from repeated attacks of acute, or subacute, amygdalitis, and the soft, or adenoid, which is the more frequent variety and occurs earlier in life. The former is apt to be accompanied by more or less chronic pharyngitis, and to persist after puberty, marked examples having been observed in advanced life. The second variety of hypertrophied tonsil is almost always associated with lymphoid hyperplasia in the nasopharynx, as well as at the base of the tongue. In other words, the hypertrophy includes what has been called "the lymphoid triangle," or "ring of Waldeyer." The mucous membrane of the follicles, rather than the parenchyma of the tonsil, is affected. The tonsils may be excessively enlarged only when acutely inflamed. They atrophy earlier and more completely than the hard variety, but frequently the former merge by slow gradations into the latter in consequence of repeated attacks of inflammation resulting in the formation of new connective tissue. The hard tonsil is hyperplastic, the stroma of the gland being developed by the growth and proliferation of connective tissue. The second form of enlarged tonsil is a genuine hypertrophy, the glandular tissue being mainly involved.

From a clinical standpoint with special reference to treatment we may divide enlarged tonsils into three varieties: first, those whose size interferes with deglutition or respiration; second, flat tonsils not especially enlarged but prone to recurrent attacks of inflammation and frequently the foci of suppurative inflammation, the formation of pus taking place not necessarily in the body of the tonsil, but in the adjacent tissue; third, a class of tonsils in which there is little or no apparent hypertrophy or encroachment upon the pharyngeal space because of adhesions of the pillars to the surface of the organ as a result of repeated attacks of inflammation. Thus the tonsil, in the process of hypertrophy, carries with it the palatoglossal fold which is spread over its surface as a thin veil; or the

anterior pillar may be considerably thickened. In either case adhesions should be released if possible before attempts at reduction or removal of the gland are undertaken. Considerable shrinkage of the tonsil is observed to take place after this procedure.

The degree of enlargement varies greatly in different cases. There may be hardly perceptible swelling, although the crypts are in a state of chronic disease, or the tumefaction may be so extreme as to bring the tonsils almost in contact. Usually the hypertrophy is more or less symmetrical; in rare instances one tonsil is large, the other being nearly normal. The latter condition gives reason to suspect the existence of syphilis, or the development of a neoplasm. When the formation of connective tissue is a marked feature the surface of the tonsil is smooth, the crypts being, to a greater or less degree, obliterated. The tonsil looks dense, hard, and fibrous. The true hypertrophied tonsil, in which the lacunæ are chiefly involved, is irregular in contour and even lobulated.

The *symptoms* caused by hypertrophied tonsils are variable. There is no pain except when they are inflamed, but there may be discomfort and a sensation like that caused by a foreign body, with desire to swallow and, at times, some dysphagia with tendency to regurgitation of fluids through the nose. Usually the development is very gradual and the surrounding parts become accustomed to their presence. Reflex vomiting has been reported in some cases, and gastric disturbance is mentioned by many observers, either as a reflex neurosis, or from irritation of the alimentary canal by perverted secretions. Earache, impaired hearing and *tinnitus aurium* are referable to the condition, but are more likely to depend upon an associated lymphoid hypertrophy in the vault of the pharynx. The latter condition, also, is usually responsible for mouth breathing and the heavy, stupid facial expression seen in children the victims of this anomaly. Reflex asthma and paroxysmal cough have been cured by ablation of these bodies. Enlargement of the tonsil is probably never congenital, although it has been met with at a very early period of life, and it is not unusual to find examples of it in several members of the same family. Those affected may be inclined to a strumous diathesis, or have a feeble constitution. But, on the other hand, we not infrequently meet with this condition in those who present no evidence of scrofulous taint or malnutrition. It rarely makes its appearance after maturity and,

in many cases, we secure a history of previous attacks of acute inflammation. It is a curious fact that, in some cases in which repeated attacks of tonsillitis occur, there is no decided increase in the size of the tonsils; while, on the other hand, we now and then see extreme hypertrophy without special tendency to acute inflammation. The damage caused by enlarged tonsils includes not only the immediate neighborhood of the pharynx but the general health. They also play an important part in the matter of infection and are a serious complication in the event of contagion. They are a source of constitutional disease by the mechanical impediment they offer to respiration and by vitiation of the inspired air resulting from decomposing secretions incarcerated in their diseased lacunæ. In addition various reflex disturbances are referred to them. Yet, in spite of the mass of evidence against them, we still hear the advice given to allow the patient to *outgrow* the condition. There is no valid excuse for such advice. While a child is outgrowing the enlargement he is exposed to all the dangers that have been recounted, whereas, under modern methods of operating, the risks of surgical interference have been reduced to a minimum. The danger attending their removal is far less than that involved in the retention of diseased or hypertrophied tonsils in the pharyngeal cavity. The improvement in general health and in the local conditions, which almost invariably follows removal of the offending bodies, is sufficient argument in favor of the operation.

Treatment.—The constitutional treatment of enlarged tonsils is seldom satisfactory. The best of hygiene, and diet, and the use of the most powerful tonics are not capable of eradicating the fibrous tonsil. Nevertheless, anything which tends to improve the general health should be employed as an adjunct to local treatment. In some instances, a soft tonsil is reduced to some extent by the use of astringent applications, or interstitial injections of iodine or corrosive acids. Massage of the tonsil has been recommended by many and seems to have been used with success in some cases. The process of absorption is assisted by compression of the tonsil, and electrolysis has been resorted to for a similar purpose. But these methods are all tedious and are justifiable only in case of contraindication of more radical surgical measures. As to the latter it becomes necessary to determine the method of operating best adapted to a given case, as well as the

best time for operating. The suggestion is sometimes made that it is better to postpone interference until improvement in the general condition has been secured. I have never seen reason to consider interference premature even in children who appeared to be in extremely poor general condition. It is not wise to operate upon a tonsil when it is acutely inflamed, although it has often been done and is still advised by some. The pain, the subsequent reaction, and the hemorrhage are apt to be unusual under these circumstances; nevertheless, we should not hesitate to interfere in case of threatened asphyxia from extraordinary swelling. It is injudicious to operate during the prevalence of an epidemic of scarlet fever or diphtheria, and indeed some go so far as to interdict the operation in a general hospital. In view of the startling frequency with which the Klebs-Loeffler bacillus, not to mention other septic organisms, has been found on the surface of a tonsillotomy wound such advice may not seem misplaced. The mode of operating depends upon the shape, the size and the relations of the tonsil. The best instrument when the tonsils are prominent is the amygdalotome; but, in certain cases, owing to the peculiar shape of the organ we must resort to other methods. Again fear of hemorrhage, which is justified in some cases, compels us to select a bloodless substitute for the knife. Various chemical caustics have been tried with more or less success. Nitrate of silver, fused on a probe and passed into the crypts, chromic acid applied in a similar way or inserted into the body of the tonsil through small incisions and London paste applied to the surface of the tonsil with a spatula, have given some degree of satisfaction. These agents have to be reapplied at intervals according to the amount of execution they do and the degree of reaction that follows them. The Paquelin cautery and the galvano-cautery are much more energetic and precise, and in proportion to their greater effectiveness they are more painful and are followed by more intense reaction. In a trained, tolerant patient, after application and interstitial injections of cocaine, the whole tonsil may be destroyed with the electric cautery at a single sitting (Cullen); but, with a view to the patient's subsequent comfort, it is well to be satisfied with partial destruction of the gland at one time, accomplishing its complete removal in numerous sittings. Galvano-cautery puncture is adapted to flat embedded tonsils, the removal of which with the knife or guillotine is difficult or impossible. It is a good plan to

cauterize three or four adjacent crypts in succession, the cold electrode being passed to the bottom of the crypt and brought out hot to the surface of the tonsil. In this way large segments of tonsillar tissue are destroyed and there is little or no danger of retention of sloughing tissue which may become a focus of suppuration. The electro-cautery method of dealing with enlarged tonsils is objected to on the ground that it leaves a large uneven surface and a sensitive cicatrix, but if it is used with discrimination there is no reason why the stump should not be perfectly smooth and insensitive. Enucleation of the tonsil by means of the finger, a method used and abandoned long ago, promises to be revived, especially by those who favor removal of every vestige of the tonsillar mass. It is sometimes easy to strip up the tonsil, together with its capsule, in its upper portion, but adhesion becomes more firm as we approach the lower part, where the nutrient artery enters. For this reason, as well as a precaution against hemorrhage, particularly in adults, it is good practice to snare off the lower half with the cold wire loop. Or the entire operation is effectively done with the wire snare, the tonsil being drawn into the loop by a properly constructed forceps (Fig. 97). In adults with prominent tonsils somewhat constricted at their base and in children under general anesthesia the latter is a most excellent way of operating.

The hot-wire snare offers advantages over the cold-wire in com-

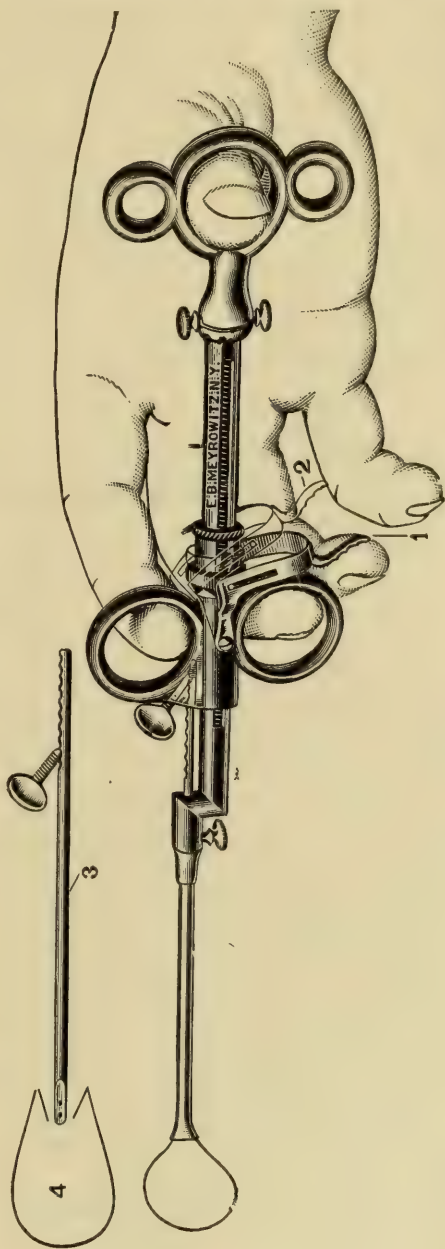


FIG. 97.—Farlow's Improved Tonsil Snare.

pleting the section more easily and rapidly and in providing greater security against hemorrhage. We meet here also with difficulty in engaging the tonsil in the wire loop which the author has endeavored to overcome by constructing a loop-adjuster or electric tonsil-snare. It is an adaptation of an idea proposed by Toison for the cold-wire *écraseur* and consists of a double canula carrying the wire and attached to a solid steel shaft from which it is insulated (Fig. 98). The shaft ends in a ring whose vertical diameter is longer to correspond with that of most tonsils. In using the instrument the wire loop is shaped to adapt itself to the ring (not as shown in the cut) to which it is fastened by a fine thread. The ring having been carried over the tonsil with the loop toward the median line, traction is made so as to bring the wire in contact with the tonsil above and below; at this instant, the current being turned

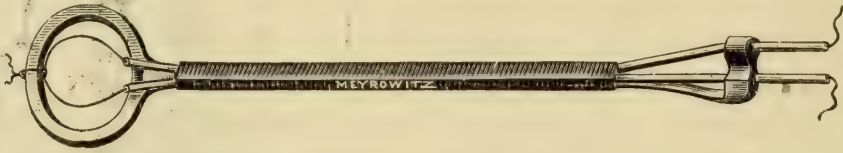


FIG. 98.—Author's Electric Tonsil-snare.

on, the wire burns through the thread which holds it to the ring. The loop buries itself in the tonsil and is no longer in danger of slipping. The advantages of this instrument are that the loop can be carried well over the base of the tonsil and the pillars and tongue are held away by the ring and protected from the heat of the current. In using electricity it is to be always remembered that the heat must be allowed to do the work and should not be excessive. Traction is made upon the wire only when it is cool. Thus traction and burning are made in alternation.

The total result of the operation is not limited to the tissues actually removed, the parts left behind being cauterized to a considerable depth. The pain of the operation itself may be almost completely abolished by parenchymatous injections of cocaine, or alypin. The latter is much less poisonous than cocaine, and its analgesia is equally prompt and prolonged. It may be kept sterile, or may be made so by boiling without damage, and there is no possibility of septic infection from its use hypodermically.

Obviously the electro-cautery loop method of treating enlarged tonsils is adapted only to adults, to children under general anesthesia,

and to protuberant tonsils. It cannot be used with flat deep-seated tonsils. The reaction is always considerable but may be controlled in a measure on general principles. It is a good plan to remove at one sitting but one tonsil, the second being attacked at the expiration of a week or ten days.

There are four conditions which justify the use of the electric cautery as a substitute for a cutting operation: (1) Hemophilia; (2) vascular anomalies; (3) peculiarity in the shape of the tonsil, and (4) refusal on the part of the patient to submit to the knife.

A patient known to be a bleeder should never be cut.

Among vascular anomalies, a misplaced ascending pharyngeal artery or a large vessel in the margin of the anterior pillar, may be wounded by the knife. Injury to the plexus of veins at the lower border of the tonsil may give rise to hemorrhage; and an abnormally large tonsillar artery frequently bleeds freely. It is impossible to tell from the appearance of the tonsil whether hemorrhage is to be expected; a vascular looking tonsil often bleeds but little. In my experience this accident has occurred usually in adults with the hard fibrous tonsil in which the section has been made near the middle of the gland where the blood-vessels do not readily retract in consequence of a preponderance of new connective tissue. In the opinion of A. A. Bliss the tonsillar artery itself is seldom cut, unless the excision be very complete, which he concludes is rarely if ever necessary. This view is also held by Damianos, who in reporting a fatal case in a hemophile states that about 150 cases of severe bleeding after tonsillotomy are on record, seven of which were fatal. His objection to complete removal seems to be based on the idea that the tonsillar artery is so embedded in the inelastic fibrous capsule of the gland that its severed end is prevented from contracting.

Anatomical peculiarities comprise the flat or embedded tonsil, the so-called "submerged" tonsil, which cannot be included in the ring of the guillotine and with which the use of the knife or scissors is tedious and possibly dangerous. Adhesion of the anterior pillar, in this situation described by Harrison Allen as the "opercular fold," and the advisability of its detachment have been already referred to. For this purpose it is well to avoid a sharp and especially a pointed instrument. Adhesions are usually easily separated with a right-angled, blunt, and somewhat dull-edged knife. Several cases of violent bleeding have followed section of this fold. Yet if the

pillar is very thin, evidently consisting only of mucous membrane, and encloses no blood-vessel of importance, its existence may be disregarded and the blade of a tonsillotome be carried directly through it, provided the tonsil protrudes sufficiently to allow the ring of the guillotine to surround it.

Although called a bloodless method of operating, burning is not absolutely free from the risk of bleeding. A number of cases are on record in which alarming hemorrhage has taken place on the fourth or fifth day from violent detachment of the eschar, as a result of excitement in laughing, or crying, or of laceration by a morsel of hard food. Ordinary caution in these particulars should ensure protection against the accident. The operation itself is rendered comparatively painless by local anesthesia, yet there is doubtless more reaction after burning than cutting. The fauces should be first thoroughly cleansed with an antiseptic spray and the surface of the tonsil swabbed with a 10 per cent. cocaine solution. Then with an ordinary hypodermic syringe six or eight minims of a 2 per cent. solution of alypin are injected into the upper and an equal quantity into the lower part of the tonsil. In about three minutes anesthesia will be quite complete.

In a large majority of cases the operation of choice is one of the various cutting methods. Most tonsils can be removed with the knife more quickly and thoroughly than in any other way, and the resulting wound is less irritable and heals more kindly than one left by a caustic. The accepted instrument for use in cutting operations is a modification of Physick's tonsillotome, proposed several years ago by Morell Mackenzie (Fig. 99). Many so-called improvements have been suggested which complicate the instrument and add to the difficulty of the operation. Mackenzie's amygdalotome recommends itself for its strength, its simplicity, its safety and its efficiency. Rightly used in suitable cases it is capable of ablating almost the entire tonsil and that without endangering the large blood-vessels in the cervical region. In certain cases a forked guillotine, like that of Mathieu (Fig. 100), is serviceable. Spear or fork attachments have been known to catch in the ring and in several instances a guillotine has thus been broken, either as a result of faulty construction or awkward manipulation. Some operators prefer a stout bistoury or scissors, but their use is far from easy in a field obscured by blood and constantly shifting with

muscular contractions. It is sometimes difficult to remove the morbid tissue thoroughly and tonsil punches in a variety of shapes have been devised for the purpose of reaching the bottom of the tonsillar fossa and the so-called "velar lobe" at the upper border of the



FIG. 99.—Mackenzie's Tonsillotome.

tonsil. In order to protect the patient against recurrence of circumtonsillar phlegmon it is quite important to remove these deep-seated masses. For this reason and because tonsillar remnants sometimes become inflamed or hypertrophied, or even harbor tubercle bacilli, Freer urges complete excision by dissecting with



FIG. 100.—Mathieu's Tonsillotome.

the knife and decries every other method. Morcellement, or ablation of the tonsil by crushing with powerful flat-bladed forceps followed by excision of the crushed portion, called by Ruault "amygdalothripsis," is said to be a satisfactory way of disposing of these hypertrophies. The tonsil punch is adapted

to cases in which the knife is impracticable (Fig. 101). In this connection a very curious and happily rare anomaly may be mentioned as offering an obstacle to removal of a tonsil, namely an elongated styloid process. It has been met with by G. L. Richards, who was obliged to divide the bone with cutting forceps before the section of the tonsil could be completed. In several instances a lacunar concretion, or tonsillith, has been found to impede the passage of the knife blade. Such conditions are more likely to occur in adults than in children and are extremely infrequent at any age.

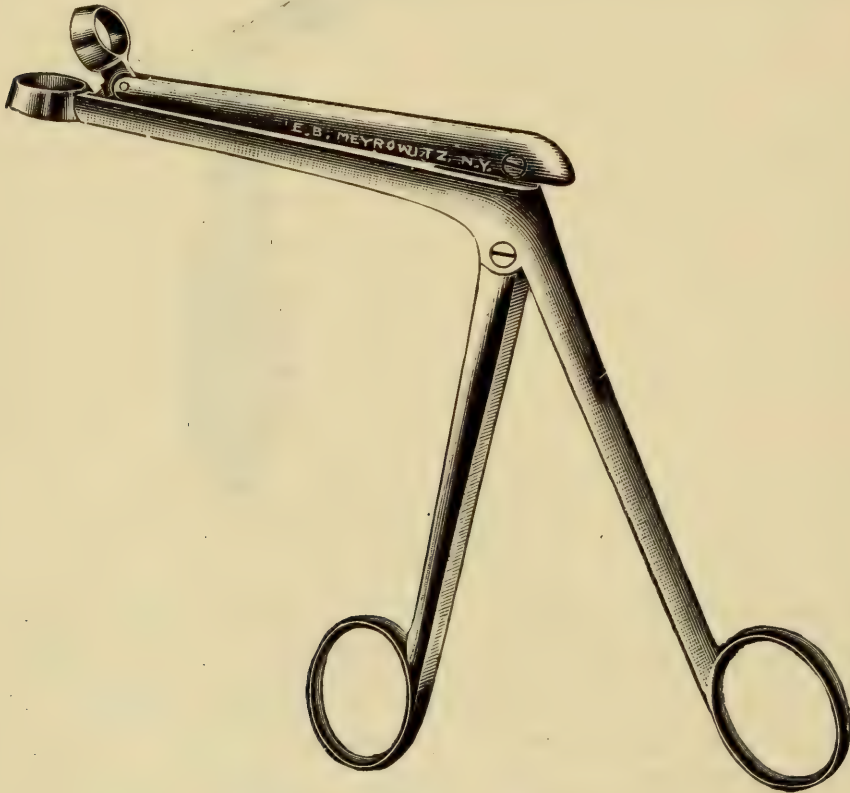


FIG. 101.—Farlow's Tonsil Punch.

It has been said that excision of the tonsils is the only operation in the upper air tract requiring the exercise of brute force, and it is certainly true that failures in the management of the Mackenzie instrument result from the use of too light a hand. Firm outward pressure with the forefinger on the shaft of the guillotine must be kept up while the blade is being closed. Otherwise the ring tends to slip off with a mere shaving of mucous membrane. The expression "brute force" needs to be modified by the adjective "reasonable." I have seen a muscular young athlete tear a large rent in the posterior pillar by the exercise of too much energy. In this con-

nection it may be mentioned that a mouth-gag is not needed in adults and without an anesthetic, and that a tongue depressor is always superfluous, the guillotine itself acting in that capacity. The remarkable feat of amputating a uvula and excising a tonsil at the same time has been accomplished by introducing a guillotine upside down, the handle pointing upward, a most unnatural and awkward position not to be recommended.

It is my custom to excise both tonsils at one sitting, the left one first and then the right. Double guillotines intended to cut both at once are awkward and unreliable. If the operation can be done without an anesthetic the patient sits facing a window, his head resting against the body of an assistant whose hands should steady the head and especially *support* the tonsil about to be excised. It is unnecessary and dangerous to try to force the tonsil inward by external pressure with a single finger. Reliance should rather be placed upon the act of gagging and firm outward pressure with the instrument to force the gland within its grasp. In removing the left tonsil the handle of the instrument should be held in the operator's right hand. The shaft, the blade being open, is passed over the dorsum of the tongue, turned quickly so as to bring the fenestra over the tonsil, and pressed firmly outward with the forefinger of the left hand. This pressure upon the shaft of the instrument and the act of gagging provoked by the presence of the guillotine in the fauces, drive the tonsil well into the ring, advantage of which should be taken to push the blade home with the thumb of the hand holding the instrument. Usually the excised portion of tonsil is held by shreds of mucous membrane in the groove of the ring. The instrument is quickly withdrawn, opened, and the manipulation repeated upon the right tonsil, the guillotine being held in the operator's left hand. Used in this way the Mackenzie instrument will make almost a complete enucleation of the tonsil in most cases. It is customary to have pretty sharp bleeding for a few moments at the completion of the operation. In several cases an alarming secondary hemorrhage has taken place a considerable time after operation. For example, in one reported by Moure a week had elapsed. In one of the author's cases the bleeding occurred on the second and in another on the fifth day. Several times in my experience it has seemed wise to abandon a contemplated adenectomy on account of excessive loss of blood from an excised tonsil. If the hemorrhage does not sub-

side after a few minutes it is time to consider measures for its arrest. In most cases the application of cold externally and holding bits of ice in the mouth will suffice. If these fail, a mixture of tanno-gallic acid—one part of gallic and three parts of tannic, in the proportion of about twenty grains to the ounce of water—is used as a gargle; and small quantities of the solution may be swallowed; the act of swallowing driving the styptic into the stump of the tonsil. Paren-

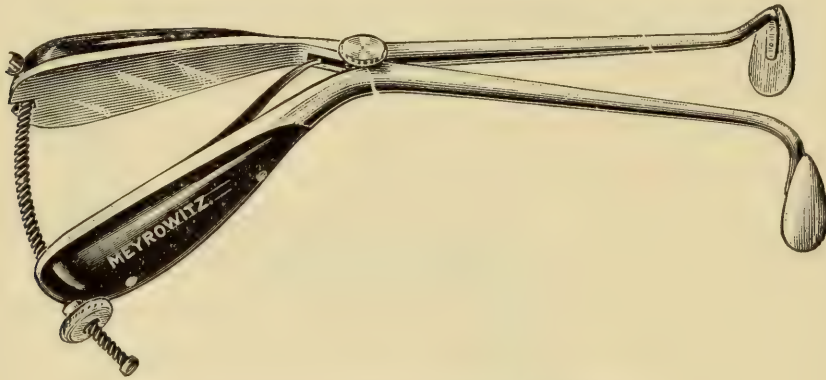


FIG. 102.—Butts' Tonsillar Hemostat.

chymatous hemorrhage is almost invariably checked by this procedure. Hemorrhage from a large tonsillar artery cannot be thus controlled and we then shall be obliged to resort to some other method. Direct pressure by the finger, or by means of one of the various tonsillar hemostats (Fig. 102,) should be tried without wasting time over styptics (Fig. 103). Ligation of the tonsil after transfixing the stump with a tenaculum is sometimes feasible; but it is not easy to

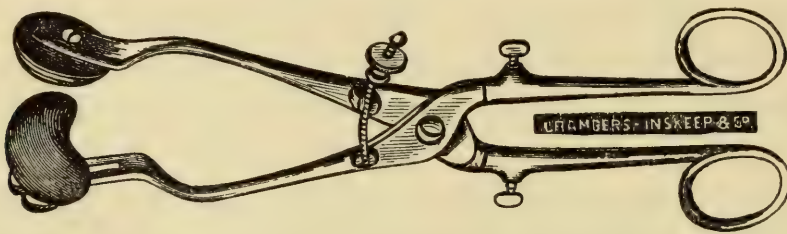


FIG. 103.—Mikulicz-Stoerk Tonsil Hemostat.

ligate a tonsillar artery from which brisk hemorrhage is taking place in a nervous frightened child, or even in an adult. The electric cautery, or Paquelin cautery will check persistent oozing but will rarely control an arterial jet. An ingenious proposition by Levis succeeded in an obstinate case under his care; the stump of the tonsil was transfixed by a tenaculum; it was then twisted to bring the flat handle between the teeth and the jaws were bandaged

together; on withdrawing the instrument next day there was no return of hemorrhage. When hemorrhage is to be apprehended from any source Seifert advises the use of the galvanocautery snare in operating and suggests that one be content to remove not more than three-fourths of the tonsil, the latter precaution, however, appearing somewhat superfluous in addition to the former.

Ligation of the carotid artery for tonsillar hemorrhage has several times been done, but in at least one such case it seems clear that the bleeding was on the point of ceasing spontaneously. On anatomical grounds the external carotid, between its superior laryngeal and ascending pharyngeal branches, is the vessel indicated for ligation, but in view of the fact that the importance of this accident has been vastly overdrawn a less formidable procedure would seem to be preferable. If a stump of tonsil has been left the loop of a cold-wire snare may be passed over its base and gradually tightened, or if the excision has been complete the tissues may be transfixed with a needle in a long handle and the wire slipped over its ends. A very ingenious device by Dawbarn consists in surrounding the bleeding area with a submucous ligature, or "purse string" ligature, passed in four directions. A double-curved needle in a holder and loaded with a stout ligature of silk or catgut is passed from before backward beneath the bleeding point, then vertically upward behind it, then directly forward and finally downward to the spot where the needle first entered. The pillars need not be included by the ligature which is practically buried at all points and is allowed to slough out or is removed after two or three days. In several cases bleeding has been checked by suturing the pillars firmly together. In most cases a tonsillar hemorrhage, if allowed to take care of itself, ceases spontaneously on the supervention of faintness with decreased blood pressure, and the last remedy used gets the credit of having checked the bleeding. This is not an agreeable mode of controlling a hemorrhage, but the episode is robbed of most of its terrors when the patient can be assured that nature's way of stopping a leak in a blood-vessel is usually effective. The results of careful study of this subject made by Lefferts have been amply confirmed by others. His conclusions were (1) that a fatal hemorrhage after the operation of tonsillotomy is very rare; (2) a dangerous hemorrhage may occasionally occur; (3) a serious one, serious as regards both possible immediate and remote results, is not very unusual; and (4) a moderate one, requiring

direct pressure or strong astringents to check it, is commonly met with. My own experience with alarming hemorrhage is limited to five cases, two in adults and three in children under ten years of age. In all the guillotine was used. In two of the children the bleeding ceased spontaneously after the failure of several domestic measures and when exsanguination had become extreme. In one a tonsil hemostat had to be applied and was worn all night. In one of the adults direct pressure seemed to be of some service, while in the other efforts to stop the flow by torsion and electric cautery were unsuccessful, the bleeding ceasing on the occurrence of fainting.

The use of general anesthesia in removing tonsils has been the subject of much discussion. The pain of cutting or burning may be mitigated in some degree by the application of cocaine, or the parenchymatous injection of cocaine or alypin. It has been suggested that cocaine increases the liability to secondary hemorrhage. General anesthesia seems to me, by all means, more humane, especially in young children. The argument against it that it deprives us of the assistance of the patient in preventing the admission of blood to the air passages, is not valid if the anesthesia be not profound. Cases of fatal asphyxia are on record from the entrance of blood into the larynx during tonsillotomy under chloroform. Some maintain that anesthetization excites as much resistance as attempts to excise the tonsil without it. My own position is that if given in a proper way, in suitable quantities, ether is on the whole the most satisfactory and certainly the safest anesthetic. If preceded by nitrous oxide gas, a very moderate quantity is required, the suffocative effects of ether are obviated, the reflexes are not abolished, and the unpleasant after effects are much reduced. By giving a general anesthetic in this way we incur no greater risk, we save the patient much nervous shock, we permit ourselves better opportunity to examine the case carefully and especially to explore the naso-pharynx, always a most important thing to do, and if any morbid condition is found there it may be relieved at the same time. It is best to remove the faucial tonsils first in succession, the mouth being held open by a mouth-gag; the patient is then turned upon the side or the face to permit the blood to drain from the mouth, and, after the hemorrhage has subsided, he is replaced upon the back and a rapid exploration made of the vault of the pharynx with

the forefinger. It may be necessary to give a little more ether when this additional step is taken.

It seems to be a fact that the danger of hemorrhage has been much exaggerated. The number of cases of excessive bleeding on record in proportion to the number of tonsils removed is extremely small. Nevertheless, especially in adults, the possibility of its occurrence should be borne in mind, and before the operation is undertaken the patient should be thoroughly informed and, if an adult, should be, in a measure, allowed to select the mode of operation.

The question of the advisability of removing enlarged tonsils is no longer open. Their injurious effects are so obvious, the



FIG. 104.—Robertson's Tonsil Scissors.

benefit following their removal is so apparent and the risks of the operation are so slight, that there should be no hesitancy in advising it when the necessity arises. We should endeavor to remove as much of the morbid tissue as possible, in other words to do a "tonsillectomy," and in order to accomplish this it is necessary to resect deep-seated masses with scissors (Fig. 104), knife (Fig. 105), or tonsil punch, as a supplement to the use of the guillotine. It is not sufficient to make a superficial section for the reason that a remnant of tonsillar tissue containing diseased follicles is very prone to become the subject of an acute inflammatory process under circumstances which excited its occurrence before operation.

It rarely happens that the faucial tonsil reproduces itself after radical excision. In very young subjects with a tendency to lymphoid hypertrophy there may be a slight inclination to recurrence. But, as a rule, the improved general condition following a nearly complete extirpation results in progressive shrinkage of what small stump is left. On the other hand, in certain cases a moderate growth of lymphoid remnants may take place precisely as in the case of adenoids in the pharyngeal vault. Yet the experience of Coakley, who states that he did amygdalotomy four consecutive times within as many years on the same patient, is most extraordinary.

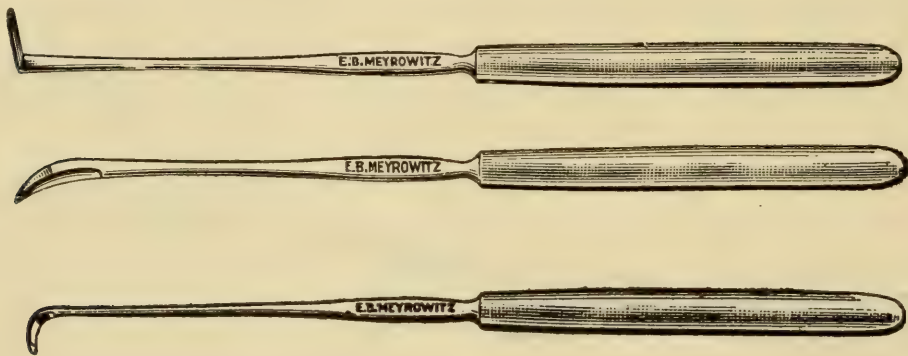


FIG. 105.—Abraham's Tonsil Knives.

Three questions are almost invariably asked whenever a tonsillectomy is proposed; whether there is any risk from hemorrhage or other sources, second, if the tonsils are likely to grow again, and finally what effect if any their removal may have upon the voice or other function. The first two have perhaps been sufficiently discussed. A fear of sexual impairment sometimes suggested is based upon a process of reasoning similar to that which discovers in suicidal mania a direct result of excision of the tonsils because two or three individuals are reputed to have taken their own lives shortly after having been cut. The question of damage to the voice deserves to be treated more seriously and is more important especially in those whose livelihood or enjoyment of life is involved. At intervals this objection finds expression in medical literature. Personally I have never experienced a case which gave it a shadow of foundation. At first there is almost always a startling change in the quality of the voice which may disturb the patient and distress his friends, but this passes away in a few weeks at most, and is succeeded by marked improvement in fullness and resonance as

he learns to modulate his voice and adapt his palatal muscles to their new relations.

A curious post-operative phenomenon, at times possibly leading to confusion and even alarm, merits passing notice, namely, "tonsillotomy rash." It is extremely rare, having been mentioned only by Lennox Browne and one or two other writers, but has recently been described anew by Wyatt Wingrave and E. A. Forsythe. It occurs as a papular, roseolar or erythematous eruption, usually beginning on the neck, chest and abdomen and thence extending sometimes to the extremities. It may be attended by considerable itching, but disappears in two or three days without desquamation and with little or no constitutional disturbance. Its occasional occurrence should be kept in mind with a view to escaping a possible disquieting error in diagnosis.

In conclusion no good reason can be offered for allowing the tonsils to remain when they are clearly proved to be causes of local as well as systemic derangement, and no method of removal other than surgical is worth considering, except in those very rare conditions which have been enumerated.

CHAPTER XIV.

DISEASES OF THE LINGUAL TONSIL. ABSCESS OF THE TONGUE.
RETROPHARYNGEAL ABSCESS. MYCOSIS OF THE PHARYNX.

HYPERTROPHY OF THE LINGUAL TONSIL.

The lingual tonsil is composed of tissue analogous in all respects to the lymphoid tissue situated between the palatal folds and in the vault of the pharynx. This tissue exhibits similar pathological changes wherever found and in its enlarged state at the base of the tongue causes peculiar symptoms which are very apt to be misinterpreted. When we consider that hypertrophy of the lingual tonsil must impede the action of the epiglottis and the movements of the tongue it is easy to understand how functional disturbances may result. It is a notorious fact that changes in the lymphoid tissue in this situation are often met with late in life and in the female sex.

The symptoms which it causes vary greatly in different persons. They are dependent not so much upon the degree of the hypertrophy as upon the temperament of the individual. A moderate amount of hyperplasia, in some cases, excites an extraordinary degree of disturbance. A sense of fullness and tickling in the throat and a constant desire to clear the passage by the act of hacking or coughing are most often complained of. The condition is a serious one in those who use the voice, either in singing or public speaking. The effort to overcome the mechanical obstacle offered by a mass of lymphoid tissue at the base of the tongue demands the exercise of muscles which should not be employed in voice formation; and, in consequence, the patient soon becomes hoarse and tired, and may actually lose his voice for a time. Finally structural changes are engendered in some part of the vocal apparatus productive of partial or complete aphonia. Reference has already been made to the morbid conditions of the vocal bands met with under these circumstances. A number of reflex symptoms have been detailed in the line of neuralgic pains, asthmatic attacks, spasm of the glottis, etc., which are comparatively rare occurrences. R. Levy divides these cases into six classes. First, those attended merely by discom-

fort, or paresthesia. Symptoms may have been excited and the mind of the patient fixed upon this locality by swallowing a foreign body or a rough particle of food, and the patient seeks to be relieved of something which he imagines is still sticking in his throat. Some of these people consult a physician because they apprehend cancer or tuberculosis. In a second class cough is a very persistent and distressing symptom, which is only temporarily controlled by sedatives, but yields promptly after the use of the galvanocautery in adults and in children to swabbing with tincture of iodine and glycerine. Third, dysphonia, vocal fatigue, throatache and impure tone production are especially noted in singers, to whom these conditions are of the utmost moment. Fourth, dyspnea, resembling that caused by spasm of the larynx and occurring chiefly at night, may



FIG. 106.—Hypertrophy of Lingual Tonsil. (*Grünwald.*)

be so extreme that the patient dreads going to bed, and eventually the general health may suffer from loss of sleep and mental distress. Fifth, dysphagia may exist to a degree sufficient to impair nutrition, and sixth, hemorrhage may occur from an associated lingual varix. The last is certainly rare. Nevertheless in view of the extreme disquietude caused by the appearance of blood in the sputa it is a satisfaction to be able to assure a patient that it comes from the base of the tongue and not from the lungs.

The diagnosis is usually made without difficulty by simple inspection with the laryngeal mirror (Fig. 106). Irregular masses of lymphoid hyperplasia, frequently covered with enlarged veins, are seen which sometimes incarcerate the tip of the epiglottis. The masses are in some cases so large as to be distinctly pedunculated

and are visible without the mirror through the open mouth. Protrusion of the tongue fails to separate its base from the epiglottis. A most conspicuous feature in the picture is often the remarkable size and number of varicose vessels. The presence of multiple turgid vessels should of course restrain us from the use of cutting instruments in this region. In elderly people lingual varix is very commonly observed and rarely possesses any significance. It may exist without much hypertrophy of lymphoid tissue, and may be associated with varicose vessels in other situations.

The symptoms are sometimes relieved temporarily by painting the region with cocaine. In many cases the condition is aggravated by impaired general health, neurasthenia, or deranged digestion. Improvement in these particulars under general medication, combined with the local application of astringents, often effects a cure. In other cases, persistent cough and phonatory disturbance demand more energetic treatment and we are compelled to resort to destruction of the masses by the use of caustics, or the electro-cautery, or to removal by means of the snare or the knife. The process of cauterization with electricity is painful and disagreeable while effective if perserved with. The knife in this region is dangerous for the reason that the parts are vascular and it is not an easy place in which to control bleeding by pressure. The cold-wire snare is, perhaps, equally effective and certainly safer, but we need for this purpose an instrument of unusual power. Various lingual tonsillotomes have been proposed shaped very much like the guillotine used in excising the faucial tonsil, but somewhat curved to fit the dorsum of the tongue (Fig. 107). The reaction from the operation of removing these masses is sometimes considerable, especially when the electro-cautery has been used, and is best relieved by holding pieces of cracked ice in the mouth, or by the application of cocaine.

The lingual tonsil is no doubt subject to inflammatory attacks precisely as are the other lymphoid masses in the "adenoid triangle," or "lymphoid ring." In the opinion of H. L. Swain, who has seen a number of cases, the condition is often overlooked. A series of sixteen cases has been reported by Seifert and almost an equal number by other observers. They may be less frequent, or perhaps less clearly recognized, than similar affections of the palatal tonsils, or possibly the intensity of the process in the latter overshadows a concomitant trouble at the base of the tongue. Phlegmonous

inflammation, or "lingual quinsy" is a very serious disease. It rarely extends beyond the anatomical limits of the tonsil, but when it does invade the floor of the mouth it resembles a true "angina Ludovici." The constitutional disturbance is extreme, as indicated by the high temperature and rapid pulse. Pain is severe and constant and is intensified by attempts to speak or swallow and by the slightest movement of the tongue. The swelling may be enormous so that the tongue protrudes from the mouth and there is a continuous dribbling of saliva. The breath becomes horribly fetid and the tongue is covered with a thick leathery fur. Dyspnea may

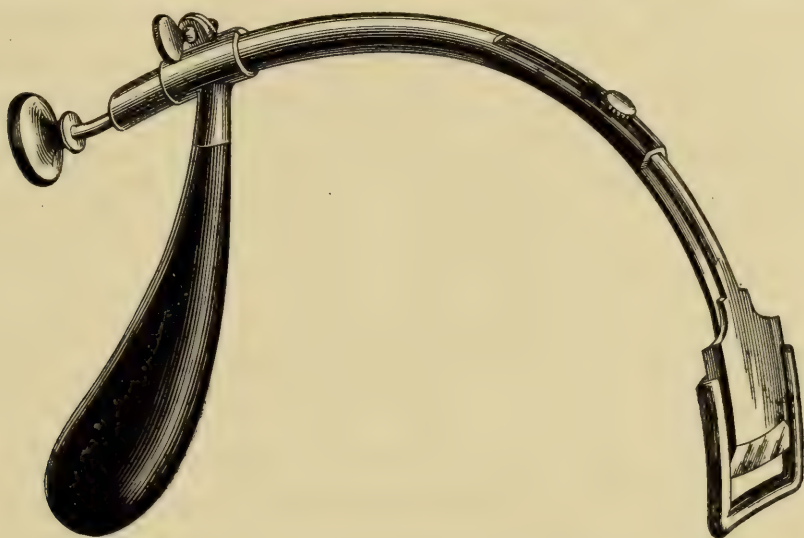


FIG. 107.—Roe's Lingual Tonsillotome.

result from swelling or from edema of the epiglottis and the vestibule of the larynx. The danger from this source, or from asphyxiation following a rupture of the abscess, is considerable, especially in the aged and in those weakened by long illness.

It is difficult or impossible to introduce the finger for palpation, and even if we succeed a sense of fluctuation is very obscure and indecisive. We may be forced to make a diagnosis without even a glimpse of the parts involved.

From this brief description it must be clear that this is a much more serious and alarming process than similar affections of the other tonsillar masses. Fortunately it is much more infrequent. Doubtless some of the cases of so-called "abscess of the tongue," and very likely the fatal cases of alleged "quinsy" should be classified under this designation.

The causes acting to excite inflammation of other lymphoid tissue

operate equally in the case of the lingual tonsil. A depressed state of the general health, a rheumatic diathesis, or a foreign body may be concerned as factors in the causation of inflammation of the glands at the base of the tongue. An interesting example of the last-mentioned cause was observed by the author many years ago, in which a wisp of straw taken into the mouth with a draught of water became engaged in one of the lingual follicles. After several days of extreme distress the patient was relieved by spontaneous rupture of the abscess.

The general treatment should be conducted on the lines laid down in speaking of the faucial tonsils. Early and free incision for the release of pus, and even if the presence of pus cannot be demonstrated, is clearly indicated. The best instrument for this purpose is a sharp-pointed curved bistoury with a rather short thin blade. Hemorrhage is apt to be very free. If an abscess is opened and pus evacuated the relief of symptoms is immediate, and in any case scarification does no harm. Hot alkaline and antiseptic mouth-washes and hot fomentations externally are usually soothing and grateful. The necessity for stimulating and supportive treatment may be urgent.

Neoplastic formations and tumors in the region of the lingual tonsil are rather uncommon. Among the most interesting of the latter may be mentioned accessory thyroid tumors, instances of which have been reported by H. T. Butlin, J. E. Schadle and others. A remarkable phenomenon in a case recorded by Schadle was presented in the form of vascular turgescence of the tumor during a period of suppressed menstruation. This growth was removed by McBurney by an external incision, its real nature not having been previously fully determined. In a case reported by Theisen an accessory thyroid as large as a hen's egg was observed deeply embedded in the base of the tongue. It appeared to be quite vascular, which fact together with the patient's age (67) was thought to preclude operation. The tumor diminished somewhat in size under internal use of thyroid extract. An interesting point in the history is that the woman had a goiter in early life, all trace of which had disappeared.

RETRO-PHARYNGEAL ABSCESS.

Retro-pharyngeal abscess is a plegmonous inflammation involving the cellular, or the lymphoid, tissues of the pharyngeal wall. In

many cases no cause for the suppuration can be discovered; in a few, it succeeds abscess formation in the cervical region; in others, it is secondary to caries of the vertebræ; in a small proportion of cases it is a sequel of an exanthem; and, finally, it may be produced by a foreign body. In a large number of cases, in children, the lymphoid tissues are evidently the seat of the disease and the course of the lesion is usually extremely slow. In adults, on the other hand, the abscess is more apt to simulate suppuration in cellular tissues elsewhere and is attended by more disturbance and local reaction. In children it is usually considered a sign of struma. Its development is very slow, the general health of the child becomes gradually impaired, food is refused as the difficulty in swallowing increases and, finally, a peculiar throaty quality of the voice becomes pronounced and there is more or less impediment to breathing. The dyspnea ultimately becomes very alarming and, in fact, may be the first symptom to draw attention to the throat.

On examination the pharynx is seen to be occupied by a bulging tumor, on one side of the middle line over which the mucous membrane is glazed and tense. Usually the tumor occupies the oropharynx but, in rare instances, it is much lower and may not be visible by direct inspection. In adults the local symptoms may be much more acute at the onset and there is more or less constitutional disturbance. Pain referred to the faucial region aggravated by swallowing directs attention at once to the throat. Obstruction to swallowing is so considerable as to interfere with nutrition. Breathing is seldom seriously impeded. The appearances presented resemble those of an abscess in other situations and the diagnosis of pus formation may be confirmed by palpation with the finger; a peculiar elastic sensation or actual fluctuation may be recognized.

If left to itself an abscess in this situation usually discharges in a week or two; but, in children, it sometimes runs a very chronic course, extending over many weeks. In the latter case, while the local disturbance is not very serious, there is danger that the patient may succumb in consequence of impaired nutrition. In children and in individuals very much reduced in strength, or advanced in years, spontaneous rupture of the abscess, or opening by incision is attended by some risk from entrance of pus into the larynx. In milder cases, simple incision with a guarded bistoury and evacua-

tion of the pus results in cure. Erosion of an artery with fatal hemorrhage has occurred in several cases on record. Edema of the glottis is a complication of especial seriousness in weak children. In some instances of extensive suppuration external opening of the abscess is required by an incision along the anterior border of the sterno-cleido-mastoid muscle. This more formidable operation is demanded only in cases of extraordinary extent, or where the abscess is seated low down in the pharynx. Ordinarily simple puncture or incision through the mouth under local anesthesia will suffice. In unmanageable children a small quantity of chloroform is required. Local applications are useless since the formation of pus is generally inevitable and rapid and its evacuation is necessary. There is seldom necessity for special dressing of the abscess cavity except after an external operation. During convalescence a semi-fluid diet and the use of antiseptic sprays and gargles, especially after taking food, are plainly indicated. Attention should be given to the general health and the correction of a strumous diathesis.

PHARYNGO-MYCOSIS. KERATOSIS.

Mycosis of the pharynx, first described by B. Fraenkel, is a term applied to a fungous development which sometimes appears upon the surface of the tonsil, upon the lymphoid tissue at the base of the tongue, or within the follicles distributed over the mucous membrane of the pharynx. The vault of the pharynx also is often invaded. It consists of a deposit of spores of the *leptothrix buccalis*, a fungus which is almost invariably present in the oral cavity and yet its transference to the fauces is comparatively rare.

Impaired general health is usually regarded as a predisposing cause and, in a large proportion of those subject to it, digestive derangements are pronounced. In some cases the saliva has an acid reaction. In a small number of cases it has been observed to follow tonsillitis and diphtheria, but there is no proof of any special relationship. In a large majority of cases the patients seem to be in perfect health, and absolutely no constitutional disturbance is observed.

The symptoms which it induces are not very pronounced. It is not at all uncommon to discover deposits of mycosis in those who are unaware of any trouble whatever. Occasionally

slight hacking cough and a feeling of irritation in the pharynx are present, but there is never acute local inflammation, except as a coincidence. The appearances it presents are almost unmistakable; yet it is not a rare experience to see cases that have been diagnosed and treated as follicular tonsillitis. Such an error may occur when the fungous growth is unusually exuberant, or is attended by inflammatory conditions. The uniform absence of the latter and the colorless appearance of the exudate differentiate it positively from diphtheria. It occurs in the form of milky white filamentous tufts projecting from the surface of the membrane, usually from a follicle. If one of these projecting masses be seized with the forceps it frequently may be drawn from the lacuna with ease. Sometimes its removal is followed by the escape of a little blood. The condition is perfectly innocuous and spreads slowly. Having been removed by mechanical means or by destructive agents it frequently shows a marked tendency to recur.

The treatment of the disease is very troublesome since success depends upon the complete and thorough destruction of all the spores; should any be overlooked they will be sure to reproduce themselves. A variety of agents have been employed, including absolute alcohol, perchloride of iron, pure carbolic acid, iodine preparations and all the stronger astringents, but the galvano-cautery gives the best results. Large masses of lymphoid hyperplasia, which offer a favorable site for the development of the mycotic product, should be removed. The milder cases which give but very few symptoms may, very properly, be let alone, or be treated by simple antiseptic gargles and the correction of possible digestive disturbances. The galvano-cautery and pyoctanin are relied upon by R. P. Lincoln in the treatment of this disease. The latter is used in powder rubbed briskly into the affected region daily until all signs of the growth disappear. Enlarged follicles, or hyperplastic masses of lymphoid tissue containing the tufts may be burned away with the electric cautery or excised.

A membranous disease presenting the gross appearances of a genuine mycosis, according to Kyle and others, is a *keratosis* beginning in the submucosa. It is pronounced not bacterial, although the *leptothrix* has been found in certain cases, probably as an accidental occurrence. This is the view elaborated by Siebenmann, who maintains that the bacteria are purely saprophytic and that they

are in no respect etiological. Similar conclusions are reached by Geo. B. Wood, who thinks that the peculiar formation of keratosis is the result of a low grade of inflammation sufficient to stimulate the growth of normal epithelium and not intense enough to lead to the pus formation of an acute process or the accumulation of cheesy masses characteristic of a chronic lacunar amygdalitis. Brown Kelly expresses the opinion, based on an exhaustive study of the subject, that there are two distinct diseases, mycosis and keratosis, which present the following differences:

1. Keratosis is found in adults, mycosis at any age.
2. The cause of keratosis is unknown, mycosis is due to some derangement of buccal secretion or of the digestive tract, or possibly to a rheumatic or other diathesis.
3. The symptoms of keratosis are slight or absent, those of mycosis are pronounced.
4. In keratosis the mucous membrane is normal, in mycosis inflamed.
5. The exudate of keratosis is tough, firmly adherent, and assumes characteristic shapes, that of mycosis is soft and easily detached.
6. Keratosis affects only the tissues of Waldeyer's ring, mycosis may occur at any part of the mucous membrane.
7. Keratosis, except for the presence of leptothrix, bears no resemblance, while mycosis is similar to thrush, sarcina and other mycoses.
8. Keratosis is not influenced while mycosis may be cured by local applications.

These views are in a sense a compromise between Heryng's theory as to keratosis and that of Miller, who describes several different forms of bacilli as causative factors. According to the latter, none of these organisms can be cultivated in any known media, while Jacobson claims to have cultivated the leptothrix on potato. The pathogenic nature of the leptothrix is thought to be proved by the fact that this organism was found by Pearce in two cases extending deeply into healthy tissues. Jonathan Wright believes that the thickening of the epithelial lining of the affected crypts is a result of a chronic inflammatory process caused by the irritative action of the mycelium. Similar phenomena are often observed in other parts of the air tract. By staining sections of tissue containing the mycelium with gentian violet and Gram's iodine he was able to

demonstrate the *bacillus maximus buccalis* as well as the leptothrix. He has been unable to confirm the observation that the mycelial threads sometimes penetrate the epithelial layer and even the subjacent tissues. On the contrary he has always found them only in the lacunæ surrounded by innumerable spores.

Thus there appears to be hopeless confusion as to the importance of the rôle played by the various organisms, and after all the lesion is of interest chiefly as a microscopic picture and not by reason of any marked clinical signs.

CHAPTER XV.

TONSILLITIS. DIPHThERIA. CIRCUMTONSILLAR ABSCESS, OR
QUINSY. ULCERO-MEMBRANOUS OR DIPHThEROID ANGINA.

TONSILLITIS.

Inflammation of the tonsil may involve the mucous membrane covering the gland, that lining the crypts, or the substance of the organ itself; the first is called superficial, the second, lacunar or follicular, and the last, parenchymatous amygdalitis. These are practically stages of the same disease; the last is frequently complicated by the formation of a phlegmon, in that case constituting a circumtonsillar abscess, or quinsy. The attempt has been made to classify inflammation of the tonsils on a bacteriological basis, but clinically we find so many varieties of microörganisms in healthy as well as in inflamed throats, some of them pathogenic and others non-pathogenic, that such a classification seems to be of little or no practical value. There is an accumulation of evidence to show that the tonsils may be the avenues by which morbid germs enter the system and cases in which disease has affected the lungs, the pleura, the meninges and the joints through the tonsillar crypts are fully established.

Considerable discussion has taken place as to the infectiousness of simple inflammation of the tonsils, and while there seems to be some ground for accepting the theory of contagion it must be admitted that in nearly all cases a predisposition to the disease exists and that where epidemics occur the victims are exposed in general to similar atmospheric conditions. Moreover, it is a matter of common observation that instead of being protected against succeeding attacks, as is true of contagious diseases, one who has suffered from tonsillitis is very liable to recurrence.

A predisposing cause of tonsillitis is found in certain local morbid conditions such as affect lymphoid structures generally. Exposure to cold is recognized as an exciting cause, especially in individuals who have been overheated or are in a condition of depressed general health. There is reason to believe that, in a large proportion of

cases, the rheumatic diathesis prevails either in the individual or in the family and, from this standpoint, the theory of heredity gains some credence. In a certain number of cases errors in diet and functional irregularities in the female seem to induce an attack. In many no cause can be discovered. In acute cases it is observed that the involvement of one tonsil is followed after a few days by that of the other. In some both tonsils are affected at the same time and in all there is more or less simultaneous congestion of the fauces and pharynx.

We recognize *acute* and *chronic* forms of tonsillitis, and from a clinical and therapeutic standpoint it is unnecessary to make any further discrimination. There is usually no difficulty in identifying an acute amygdalitis and in fact a diagnosis is generally made by the patient himself. The most conspicuous local symptoms are more or less intense pain on swallowing accompanied by a sense of fullness and obstruction in the fauces. There is some sensitiveness on external pressure in the tonsillar region and indeed all the muscles of the neck are quite stiff and painful. Pain is felt in the ear of the affected side and almost constant *tinnitus aurium* may be present. Constitutional disturbance is usually decided. Headache, muscular pains, anorexia, chills and high temperature comprise a train of symptoms apparently out of proportion to a local disturbance of such simple character. On inspection of the affected parts the tonsils are seen to be red and turgid; and the palatal folds, the velum itself and the uvula are swollen and edematous. If the crypts are involved their orifices are indicated by accumulations of yellowish-white secretion which may coalesce into a membranous formation resembling the exudate of diphtheria. If the cervical glands are swollen, which is apt to be the case at a late period or in very intense forms of amygdalitis, the diagnosis is quite dubious. The voice is thick and muffled, or husky from laryngeal congestion, and the relaxed condition of the vocal bands may require attention after the subsidence of the pharyngeal inflammation. The nasopharynx, the Eustachian tubes and the middle ear may become involved in an inflammatory process, especially in those who have had previous ear trouble or who are run down in health.

In the chronic form of tonsillitis there may be little or no enlargement of the gland but the lacunæ which compose it are clogged

with epithelial débris, decomposing secretions and bacteria which are a source of local irritation and doubtless cause a modified form of general septic infection. Such tonsils are prone to acute exacerbations when their volume is temporarily very much increased. We are familiar with several varieties of reflex disturbance from these chronic inflammatory conditions referable to the acts of breathing and swallowing and, in some cases, the quality of the voice as well as its power is distinctly impaired. The odor of the breath is markedly offensive in cases of long standing in which the secretions have been retained in the lacunæ, and frequently little masses or balls of yellowish inspissated secretion are extruded which emit a very foul odor on being crushed. The theory that this condition provokes the formation of "singers' nodes," propounded by F. E. Miller, has not been fully confirmed.

In the *treatment* of acute tonsillitis the first thing to be done is to administer an active purge; a saline laxative is the most satisfactory. If febrile reaction is prominent the internal use of drop doses of aconite every hour is efficacious. Quinine is very commonly prescribed in this disease, especially when fever is marked, but probably without good reason, and, moreover, the detrimental effect of this drug upon the ears, which in many of these cases are already to some extent impaired, should be remembered. Chlorate of potash in tablets containing five grains each, one to be dissolved in the mouth every two or three hours, seems to be soothing in cases of mild type. A combination of chlorate of potash with tincture of the chloride of iron is believed by many to have a specific effect upon these septic processes, but there seems to be no valid foundation for this view, and certainly in my experience cases do equally well under doses less nauseous and less disturbing to the digestive tract.

Guaiac, in the form of lozenges or as an ammoniated tincture, may be given every two or three hours until the bowels are acted upon. The salicylates, and more recently salol, have been used with satisfaction especially in cases in which the rheumatic diathesis is conspicuous. Some of the coal-tar products, especially acetanilide and phenacetin, are popular, but should be used cautiously. During convalescence it is found necessary to resort to general tonics, since there often results a remarkable degree of systemic depression.

Locally the use of sprays, inhalations and pigments is decidedly preferable to that of gargles. The act of gargling in acute inflammation is a source of irritation and any good accomplished must be thus more or less counterbalanced. Bicarbonate of soda in powder applied with a spatula sometimes gives marked relief. Externally water compresses or poultices of flaxseed are a source of comfort. In the early stages of an acute inflammation of the tonsils the application of cold by means of Leiter's coil, or icebags, is serviceable. As a rule these cases are seen too late to be amenable to cold applications and heat is more grateful and effective. Friction of the neck with some stimulating embrocation is thought to do good by diverting the blood from the inflamed region to the surface. Swabbing the inflamed tonsil with pure tincture of iodine is said by Floersheim to give prompt relief even when suppuration seems imminent, but his experience has not been fully corroborated. In fact in some cases a decided aggravation of the subjective symptoms has been noted. It is claimed that an attack may be aborted by painting the fauces with a strong silver nitrate solution (1 dr. to 1 oz.). To most people this is an extremely disagreeable application and its value is doubtful. A mild solution is certainly irritating and useless, and the strong solution should be employed only in the early stages. Its mode of action is undetermined, whether as an antiseptic or by substituting a simple for an infective inflammation. In the experience of some attacks of follicular tonsillitis have been frequently aborted "by cleansing the tonsils with a saline solution, swabbing with peroxide of hydrogen, and then spraying with suprarenal, and repeating this treatment in twelve hours" (O. T. Osborne). A certain amount of suspicion always attaches to alleged "abortive" methods of treatment but that last mentioned has at least the negative advantage of being harmless. When several agents are used at the same time or successively it is rather difficult to decide which should receive credit for the effects observed. Pigments of menthol, 20 grains to the ounce of fluid albolene, applied at short intervals often give great relief. In the interval of the attacks any chronic morbid condition should be relieved or corrected as a prevention of recurrence.

Chronically inflamed tonsils assume a great variety of shapes. Frequently portions may be so enlarged as to permit of excision. Many are flat and so hidden behind the pillars as to be quite inaccessible. Others are riddled by distended crypts more

or less filled with caseous material, a variety known as the "honey-combed" tonsil. When the tonsils are not enlarged the treatment consists in emptying the lacunæ by scooping out the caseous contents and then obliterating the diseased crypts by the use of some chemical caustic or the galvano-cautery. If the tonsil is enlarged the best treatment is removal with the guillotine or the wire snare, hot or cold, according to indications. In case radical interference be declined something may be done by applications of strong tincture of iodine, or by inserting into the crypts a probe charged with trichloroacetic acid. Substantial results are obtained only by prolonged use of this method and with tonsils in which hyperplasia is not a prominent feature. In some of these cases habitual daily gargling with antiseptic solutions seems to be of benefit. The muscular exercise required by the act serves to empty the follicles clogged with detritus and is a healthy stimulant to the function of all the faucial region quite independent of any medicinal quality possessed by the fluid in use. By the ordinary mode of gargling only the anterior surfaces of the velum and tonsils and the dorsum of the tongue are reached. It is possible, however, for some individuals with a little practice to throw the fluid into the nasopharynx, or even the larynx, but the advantage of the latter feat in pharyngeal gymnastics is doubtful. Laryngeal gargling is far from easy, but may be effected by the method of Guinier, described as follows. A small quantity of fluid is taken into the mouth, which is held open. The head must not be thrown back lest the desire to swallow be excited. While the lower jaw is protruded so as to draw forward the epiglottis the patient attempts to phonate any vowel sound, when the fluid at once finds its way into the larynx and bathes all the region above the vocal bands, provided the tendency to swallow, or to take an inspiration, can be resisted. The method of von Troeltsch, modified by Hagen, for gargling the pharynx is somewhat easier. The mouth being about half full of fluid is held open while a partial act of swallowing is attempted. This carries the fluid well into the pharynx where the expired air is made to gurgle through it in the usual way, as long as possible. When the process of exhalation is completed the tongue is placed firmly against the upper incisor teeth and by a quick forward jerk of the head the fluid is ejected, much of it passing into the naso-pharynx and out by the nostrils (H. L. Swain). Frequent repetition of the attempts

at swallowing while the mouth is open dilates the pharynx, relaxes the velum and thus favors the escape of the fluid by the nose, provided there is no nasal obstruction. The solutions used in this way should be saline, alkaline, or mildly astringent, and should be looked upon merely as adjuvants to other therapeutic measures and modes of local medication.

A follicular tonsillitis in the acute stage is not to be regarded as a trivial matter. Cases in which septic absorption, followed by glandular suppuration, suppression of urine and other complications, has developed are well authenticated. Cardiac and arthritic complications of a sore throat are among the possibilities, and even appendicitis is now classed with the manifestations of "tonsillo-genous bacteriemia." Even in the absence of these disasters the affection is one calling for the most careful supervision, both on account of the immediate discomfort entailed and because of the subsequent systemic depression.

DIPHTHERIA.

It is not proposed to make an exhaustive review of the subject of diphtheria but it is important to be able to differentiate its local phenomena from those of other diseases which it resembles.

The early diagnosis of diphtheria is often extremely difficult and there are forms of similar membranous inflammation that are confusing. A bacterial examination may settle the question but frequently there is neither time nor opportunity for this and we are obliged to rely upon clinical signs. The discovery of the Klebs-Loeffler bacillus in connection with a false membrane, is considered definitive, but its existence in the pharynx does not necessarily prove the presence of diphtheria. Many times the bacillus has been found in individuals in perfect health. There must be, therefore, special susceptibility of the individual, or virulence of the poison, or possibly a still undiscovered toxin, to determine the actual development of the disease. In children the discovery of the bacillus even in the absence of local symptoms other than slight sore throat, should put us on our guard. Such a case should be isolated until all doubt as to the character of the condition has been dissipated. It is necessary to make a complete examination of the suspected region; small deposits of false membrane may exist at the root

of the tongue, or behind one of the palatal folds, where they may be overlooked.

A membrane so firmly attached that its removal causes bleeding is probably diphtheritic. Rapid extension of the deposit and invasion of the nasal chambers add to the gravity of the prognosis. Involvement of the larynx, especially in children, is a very serious phenomenon. Sudden fall of temperature is indicative of collapse while a rapid rise means septic absorption. A rapid pulse is not necessarily a bad sign but irregularity and weakness are unfavorable. Albuminuria occurs in a large proportion of cases but becomes serious only when complicated by suppression of urine and other signs of severe kidney lesion. In diphtheria the systemic depression is out of proportion to the local phenomena. In other words we have to deal with a constitutional disease of which the symptoms presented on the mucous membrane are a local expression. In an average case the membranous exudate seems not merely upon the surface but to be incorporated in the substance of the mucosa. The attendant hyperemia differs from that of an acute inflammation in being more livid in hue, and the subjective symptoms are distinctly less intense. A non-diphtheritic pseudomembrane may be readily removed and its careful detachment is not apt to leave a bleeding surface. The color of a diphtheritic membrane is usually yellowish white at first, but it soon becomes blackened by admixture with blood and necrotic tissue. At the same time a decided fetor of the breath is detected and the cervical glands are swollen and sensitive. A croupous membrane is thin, glazed and white, does not become discolored and is easily detached. In follicular tonsillitis the exudate is discrete and indicates the mouths of lacunæ, or if it becomes confluent does not extend beyond the surface of the tonsil.

There is reason to believe that not every membranous deposit in the upper air tract is due to the Klebs-Loeffler bacillus, while on the other hand certain non-membranous inflammations owe their origin to this organism. True diphtheria is caused by a specific bacillus or its toxins, but there are many microscopic organisms similar in character which are strictly non-pathogenic. The morphological features of the diphtheria bacillus are not reliably distinctive. The chemical test sometimes employed is not absolute. owing to varying degree of acid-producing power in different bacilli.

Animal inoculation may furnish satisfactory evidence, provided we can exclude the possibility that certain non-diphtheritic bacteria are fatal to lower animals. Moreover, pathogenic bacilli may lose their virulence in artificial cultures and hence fail to produce an effect. Immunization of a control animal with diphtheria antitoxin might be conclusive, but this takes time, a point of vital importance in diphtheria. Nearly every practitioner has had fatal cases, in which the bacteriological testimony was negative, and on the other hand has been compelled to keep a suspected patient in quarantine for weeks solely on microscopic evidence. Hence we are forced to reach a diagnosis mainly from the clinical history and local appearances, looking to bacteriology only for the somewhat uncertain confirmation it is authorized to give.

The following points in tabular form may be serviceable.

<i>Tonsillitis.</i>	<i>Diphtheria.</i>
Begins abruptly, with chill, rapid rise of temperature—104 degrees or more—headache, muscular pains and general malaise.	Comes on gradually, usually without chill.
Tonsils swollen and covered by an exudate in the form of a non-adherent pseudomembrane, or more often the mouth of each separate follicle is clogged with yellowish white secretion.	Moderate rise of temperature, vomiting and albuminous urine.
Spots or patches of membrane easily brushed off without causing bleeding and seldom reform.	Tonsils not especially large unless previously hypertrophied, but more or less covered by thick adherent membrane.
Exudate is limited to the follicles or surface of the tonsil and the mucous membrane is uniformly red.	Cervical glands apt to be swollen and sensitive.
The bacilli of a simple inflammatory process are present.	Membrane removed with difficulty and exposed surface bleeds. Returns in a few hours.
	Membrane may be found almost anywhere on the mucous surface which is not intensely red, but is usually dark red or livid around the membranous deposit.
	Pathognomonic, Klebs-Loeffler bacilli usually found.

CIRCUMTONSILLAR ABSCESS; OR QUINSY.

Circumtonsillar abscess, or *quinsy*, is an acute inflammation of the tissues contiguous to the faucial tonsil as well as of the gland itself resulting in the formation of pus. In a large proportion of cases

the focus of suppuration is located at the upper border of the tonsil and involves the soft palate. In rare instances it occurs behind the tonsil simulating retro-pharyngeal abscess; and, still less frequently, the pus is incarcerated underneath the tonsil which is pushed into the faucial space without being itself especially affected. Abscess of the tonsil proper is a rare occurrence, but when pus is formed in the situation last referred to it is not unusual for it to escape through one of the tonsillar crypts.

The valuable researches of J. L. Goodale show some interesting facts regarding tonsillar or intrafollicular abscesses. In most cases the intratonsillar process was found alone, in a few it was accompanied by circumtonsillar inflammation. There are no clinical signs which define an abscess in a follicle, except that a severe grade of infection is indicated by more profound constitutional disturbance than is met with in simple proliferative amygdalitis. Suppurative foci are often numerous, and in such case the streptococcus pyogenes is the most abundant form of micro-organism. The crypts contain a large amount of fibrinous exudate. In cases accompanied by circumtonsillar inflammation the interfollicular lymph channels and the connective tissue lymph spaces near the base of the tonsil are crowded with polynuclear neutrophiles. It is surmised, although the evidence is not yet complete, that an intrafollicular abscess is not of embolic origin but is a sequel of primary infection of a crypt by the streptococcus pyogenes and that circumtonsillar inflammation is due to discharge of a tonsillar abscess into the efferent lymph channels.

Quinsy is a rare disease in childhood and the tendency to it disappears with advancing years. In exceptional cases a first attack occurs in late adult life. In children the natural objection to an examination makes it far from easy to reach a diagnosis. Fixation of the lower jaw, always symptomatic, adds to the difficulty. If the finger can be inserted into the mouth a unilateral sometimes fluctuating tumor may be detected. The necessity of protecting the examining finger, or using a mouth-gag, is especially important. Pain and often torticollis together with marked constitutional disturbance are present. The danger from edema, or spontaneous rupture of the abscess in a child is far greater than in an adult.

The causes of quinsy are not always evident. Exposure to cold is a recognized exciting cause and seasonal influences are very

marked, cases being much more frequent during the spring and fall months than at other periods of the year. It seems to be an hereditary disease, or at least many cases occur in the same family. It is sometimes possible to get a distinct history of rheumatism in the individual or in the family; although it is perhaps less frequent in this than in other forms of amygdalitis. Previous enlargement of the tonsil seems to provide a tendency to inflammation, although cases are often observed in which the tonsillar tissue itself seems to be but little, if at all, hypertrophied.

Many cases begin as a simple acute lacunar amygdalitis. An attack of quinsy is usually announced by a chill or at least by chilly sensations. There are more or less pyrexia and systemic disturbance, muscular pains, headache and general malaise. A feeling of discomfort in the fauces soon develops into acutal pain aggravated by swallowing, and the pain may shoot up toward the ear of the affected side. As a rule, in twenty-four to forty-eight hours distinct tumefaction appears in the classical situation at the upper border of the tonsil between the palatal folds. There is some edema of the velum and uvula and the function of the velum may be so impaired as to cause regurgitation of fluids into the nose on attempts at swallowing. The voice is characteristically altered and muffled, the patient is annoyed by accumulation of thick, tenacious mucus in the fauces, the attempts to clear the passages by hawking being exceedingly painful. The salivary secretion is markedly increased and inability to dispose of it adds to the patient's discomfort. Fortunately the affection is usually limited to one side although there may be consecutive inflammation involving the second tonsil. If allowed to pursue its course spontaneous rupture of the abscess may take place either through the anterior pillar or between the pillars at the upper border of the tonsil.

From the symptoms that have been detailed there should be no question in making the diagnosis of quinsy. In some instances digital examination gives a positive sense of fluctuation but it is not always to be relied upon since the pus may be so deeply seated as to fail to give the characteristic sensation on palpation.

Cases are on record in which quinsy has been mistaken for other lesions; among them, aneurysm, malignant disease, diphtheria and syphilis; but, after a careful study, such mistakes seem hardly possible. In a case of aneurysm, supposed to be quinsy, a bistoury was

plunged into the tumor with the result of producing hemorrhage which was controlled only by ligation of the carotid artery. In this case palpation had previously detected pulsation which should have been accepted as a warning. In malignant disease there is usually more or less of an ulcerative process which does not occur in quinsy; while the rapid development of peritonsillar inflammation tends to exclude malignancy. With diphtheria there is probably more danger of confusion, at least in the early stages; but enlarged cervical glands, albuminuria and the presence of bacilli in the exudate, together with the absence of very marked or intense local symptoms establish a diagnosis of diphtheria. A syphilitic gumma of the tonsil or in its neighborhood, when inflamed, resembles quinsy, but it is rare to have acute symptoms in connection with a gummatous process and, in the majority of cases, we discover other manifestations of syphilitic infection.

As a rule, the pus formed in the course of quinsy, succeeds in finding an outlet, the patient obtains relief from painful symptoms by rupture or puncture of the abscess and recovery ensues. The prognosis, under most circumstances, is good. In some cases, the process of suppuration is slow, the tissues enclosing the pus being so brawny and tough as to yield slowly to the pointing of the abscess. The condition is practically converted into one of *chronic* abscess of the tonsil. In other cases, when the patient is very reduced in strength or advanced in years, there is danger from the escape of pus into the air-passages and the occurrence of asphyxia, or the pus may find its way into the mediastinum by way of the pharyngo-maxillary fossa. A fatal result may follow from absorption of pus and the formation of metastatic abscesses, thrombi, etc. Such occurrences are extremely rare. The pus may bore its way through the wall of a neighboring blood-vessel and lead to the occurrence of hemorrhage. Happily, the large blood-vessels in the vicinity are protected by a considerable amount of connective tissue and they are not easily reached, although a number of cases in which the internal carotid artery has been invaded are on record, all terminating fatally.

An interesting contribution to the subject of hemorrhage from a circumtonsillar abscess has been made by W. F. Chappell. In a case which he reports an abscess was opened by a small incision in the usual situation. Four days later a hemorrhage of about six

ounces occurred and was repeated in still larger amount in four hours. It was controlled by astringent applications, but five days afterward a third bleeding to about eight ounces was followed by persistent oozing. The abscess cavity distended with clots was then freely opened and packed with iodoform gauze after having been irrigated with hydrogen peroxide. Under daily renewal of this dressing the cavity healed and no more bleeding took place. After the second hemorrhage an examination of the urine showed albuminuria with epithelial and pus cells and granular casts. During convalescence a severe attack of rheumatism involving the muscles of the calves and to some extent certain joints occurred, and the opinion is expressed that this as well as the nephritis must be attributed to the tonsillar abscess. In a search of the literature of the subject this observer finds several similar cases and a surprising mortality. In most of them the internal carotid appears to have been opened by ulceration, in one the lingual artery (Thomas Watson), and in one the blood seemed to come from "rupture of a small abscess on the posterior surface of the velum" (Brewer). In Chappell's case the ascending pharyngeal artery, seen at the posterior wall of the cavity, was suspected. In a collection of 51 cases (28 fatal) of pharyngeal hemorrhage in connection with suppuration discovered by J. E. Newcomb, many interesting points are emphasized. In several the phlegmon was not in the immediate vicinity of the tonsil. Spontaneous opening of the abscess occurred in a large proportion (33) and the hemorrhage was found to have come from a perforation of the internal carotid artery. In 16 cases the common carotid was tied, once without any impression on the bleeding, eleven times with success, in one both external and internal, and in one the common, external and internal were ligated, both successful. The danger of hemorrhage arises not only from acutal erosion of a vascular wall, but from rupture of a weakened vessel consequent upon sudden evacuation of an abscess and is naturally greater the longer the pus has been accumulating. Early intervention for release of pus is clearly indicated. In case of bleeding exposure and firm packing of the abscess cavity should be practised before resort is made to ligation of the carotid.

The *treatment* of quinsy consists, in the early stage, in an attempt to abort the disease and prevent the formation of pus. Unless seen early it is impossible to accomplish this. Revulsives in the shape

of hot foot baths, diaphoretics and an active purge sometimes succeed, in conjunction with the internal use of a very old fashioned but excellent remedy, guaiac. On the rheumatic theory in recent years salicylates have supplanted the older drug but are little, if at all, more effective and are probably less safe. The alkaline treatment with bicarbonate of soda recommended many years ago has also given good results. It is used internally, as well as locally. The tincture of aconite, recommended by Ringer, is also of use. When the symptoms are very acute gargles are a source of so much pain that they are not only ineffectual but the muscular effort required seems to aggravate the local disturbance and so counteract, in a measure, any good effect they may have. The objection does not apply to the use of sprays or pigments, some of which are found to be efficacious. One of the best applications in any form of inflammation of the tonsils is a combination of the bicarbonate, biborate and salicylate of soda, of each equal parts, a teaspoonful of the mixture being dissolved in about four ounces of hot water and sprayed into the throat, or, if preferred and the parts be not too sensitive, the solution is used as a gargle. At the same time the salicylate of soda is given internally in doses of ten grains every two hours until its physiological effects are obtained. Ammoniated tincture of guaiac is used as a gargle by adding a tablespoonful to a glass of hot milk, a mouthful of the mixture being swallowed every hour until the bowels are acted upon. In the early stages external applications of dry cold in the form of ice-bags are sometimes of service.

When the foregoing measures appear to have failed and signs of suppuration are distinguished, the only resort is to surgical measures. If the pus points at the upper border of the tonsil an incision should be made through the anterior pillar with a sharp-pointed curved bistoury, the blade of the knife being held parallel to the fibers of the palato-glossus muscle and directed obliquely upward and inward. A small cataract knife is also a very convenient instrument, its triangular blade making a large vent for the escape of pus. The rule followed by Chiari is to make the incision bisect a line drawn from the base of the uvula to the last molar tooth. When the knife is passed in the situation described there is no risk of striking any important blood vessels except, of course, in the existence of some abnormality. Usually pus begins to escape before the knife

is withdrawn and relief is immediate. The preliminary application of cocaine does very little good in the way of deadening the pain of the cut which is considerable but momentary. The pus may be so deep seated as not to be reached by an incision considered safe; in such case the insertion of a blunt probe into the cut may succeed in opening the abscess wall, and, even if pus does not escape, the incision relieves tension and encourages its progress toward the surface. Sometimes the wall of a deep-seated abscess may be ruptured by plunging an ordinary polypus forceps into the wound and forcibly separating its blades.

In some cases of tonsillar abscess in which an accumulation of pus exists at the bottom of crypt or in which the focus of suppuration is just outside the tonsillar capsule, a method of treatment revived by G. A. Leland is found efficacious although somewhat heroic. Through a free vertical incision in the tonsil itself with an angular bistoury the finger is introduced and the tissues are forcibly broken down. Local anæsthesia is usually sufficient. Sometimes a dense-walled cavity is opened in which is found a quantity of pus. Reaction is seldom excessive and the relief of symptoms is generally immediate. In these cases it is supposed that the trouble begins in a tonsillar crypt, thence extending to the circumtonsillar tissue. Breaking down the tissues, as suggested by Hoffmann, and called by him "discission," may be effected by means of a large stiff probe, but the forefinger answers better.

When pus is not disclosed by scarification the process of suppuration should be promoted by hot applications externally and by means of hot inhalations and gargles. The external application most grateful and effective is a hot flaxseed poultice which should be large enough to cover the whole side of the neck and should be overlaid by a piece of oiled silk. When pus evacuates itself, or is released by incision, the inflammatory process promptly subsides and practically the attack is over. But the tendency to the disease may still remain and if predisposing causes such as enlarged tonsils are recognized they should be removed. It is not safe, however, to guarantee a patient against recurrence of quinsy after *partial* excision of the tonsils, since it not infrequently happens that an attack will take place within a few months after a tonsillotomy. Hence the necessity of a "tonsillectomy" rather than a tonsillotomy. The importance of extirpating the upper part of the tonsil as a preventive

of peritonsillar phlegmon is insisted upon. The gland is often deeply seated in the angle between the pillars to which it may be firmly adherent. The ordinary methods of excision do not reach it and it must be enucleated by a careful dissection or with a tonsil punch. Attention to the mode of life and the habits in general, and the correction of a rheumatic tendency will do more to banish a predisposition than local treatment alone. An attack of quinsy is almost always brought on by overexertion and is favored by a state of low vitality. Recovery is apt to be tedious and needs to be assisted by tonics and generous diet.

ULCERO-MEMBRANOUS OR DIPHTHEROID ANGINA.

It must have fallen to the lot of every practitioner of wide experience to be puzzled by a form of sore throat resembling diphtheria but free from violent constitutional disturbance. In these cases a true ulcerative process goes on involving a very limited area or the entire surface of the tonsil, extending through the whole thickness of the gland or affecting only its superficial portion. The mildness of the associated systemic disturbance differentiates it from a confluent follicular amygdalitis. Usually but one tonsil is involved and adjacent parts are not extensively invaded. The submaxillary glands of the corresponding side are generally enlarged and remain hard some time after the throat symptoms disappear. The gross appearance of the membrane suggests diphtheria, but no Klebs-Loeffler bacilli and indeed few microorganisms of any kind are to be found, except the *fusiform bacillus* of Vincent, which is uniformly present in large numbers and is thought to be the special microbe of the disease. Both a bacillus and a spirillum are present, the former being fusiform in shape and straight or curved and staining promptly with aniline fluids. The fusiform bacillus is found normally in the mouth and has been discovered in pus from the antrum and in that of a perilaryngeal abscess; it has not been cultivated in artificial media and has not been proved to be pathogenic to animals. Although this seems to be a comparatively mild disease, Watson Williams asserts that it is very fatal in children. Usually the membrane clears off in a week or two and the parts resume their former appearance except so far as tissue may have been destroyed

by ulceration, and even then the resulting deformity is far from commensurate with the loss of tissue.*

In a recent case in my clinic an ulcer occupied the left tonsil and the mucous membrane near the last molar teeth. It was irregular in contour, quite deep and sloughy in appearance, and was extremely sensitive. The cervical glands were implicated and were very hard and tender. Although there was no history of syphilis, the young man was put on mixed treatment and in the meantime a smear from the surface of the ulcer was examined under the microscope. The specimen was found to be crowded with fusiform bacilli. Internal treatment was stopped and the ulcer was simply bathed at short intervals with hydrogen peroxide. Repair began at once and rapidly progressed. Notwithstanding the apparent depth of the ulcer, the parts have healed with hardly a trace of damage.

The average case is much more likely to be confounded with follicular tonsillitis or diphtheria, especially the latter. Severe constitutional disturbance and clogging of the tonsillar lacunæ with inflammatory products characterize the former, while diphtheria is not an ulcerative disease, until the third or fourth week, by which time its nature is usually demonstrated by profound systemic depression. The microscopic testimony is conclusive. Although the proof is not yet absolute, this lesion is probably caused by a specific organism for reasons expressed by Sobel and Herrman, in a very complete review of the subject, as follows: the presence of fusiform bacilli in large numbers, their rapid disappearance as the ulceration heals, the scarcity of other microorganisms and the occasional transmission of the disease from one individual to another. The duration of the affection is usually less than three weeks, and may be reduced by appropriate treatment. One case (Lemoine) lasted seventy days.

The local treatment which has been found most effective has been the application of iodine in some form, preferably Lugol's solution. Nitrate of silver, in three to 5 per cent. solution, and 10 per cent. chromic acid have also proved serviceable, and recently Siredey has recommended pure methylene blue in powder rubbed well into the lesions.

*In a case described by H. Arrowsmith destruction of tissue and consequent deformity were remarkably extensive, in the latter respect showing a striking contrast with syphilitic ulceration.

CHAPTER XVI.

BENIGN NEOPLASMS OF THE TONSIL. TONSILLITHS. MALIGNANT DISEASE OF THE TONSILS. TUBERCULOSIS, LUPUS AND SYPHILIS OF THE PHARYNX. NEUROSES OF THE PHARYNX. FOREIGN BODIES IN THE PHARYNX.

Benign neoplasms of the tonsil comprise lymphoma, fibroma, papilloma, angioma and lipoma. The first is rarely seen except in combination with other neoplasms, especially sarcoma. In its simple form it is a lymphoid hyperplasia and is a local manifestation of a diathesis.

Fibromata are met with in the tonsil either as sessile tumors, or infiltrations, so to speak, or more commonly, as small pedunculated tumors springing from the mucous lining of a crypt.

Papillomata are very commonly seen on the velum and uvula and less frequently on the surface of the tonsil, invariably pedunculated and resembling the adjacent mucous membrane in color.

Angiomata are rare except in combination with, or secondary to, other neoplasms. One or two examples of lipoma are on record.

Tonsilliths, or tonsillar concretions, are now and then met with in a distended tonsillar crypt where they may give rise to very little reaction, or are productive of symptoms which might be expected from a foreign body. Not infrequently they are discovered in an attempt to excise an apparently enlarged tonsil. These concretions are composed mainly of calcareous material, phosphate and carbonate of lime and epithelial débris, frequently with a parasitic nucleus, the *leptothrix buccalis*.

The treatment of a tonsillar calculus consists in its removal followed by thorough curetting of its bed, with excision of redundant portions of tonsillar tissue. Small concretions in the lacunæ are not very uncommon. The largest tonsillith on record weighed 26.8 grammes (Robertson). It was somewhat egg-shaped, and the most remarkable thing about it was that, in spite of its enormous size, its existence was not suspected until its expulsion during a violent paroxysm of coughing. A deep excavation in the tonsil marked its site.

Malignant disease of the tonsil occurs under two forms, epithelioma and sarcoma. Either of these may be primary in the tonsil, or may reach that organ by extension from the tongue or from the pharynx. We find several subvarieties of these two forms, the most common being the round-celled sarcoma; next the squamous epithelioma and finally lympho-sarcoma. Others are practically clinical curiosities.

In the early stages of sarcoma there is a decided tendency to limitation of the disease by a definite line of demarcation from the healthy tissue, or even encapsulation, ulceration being a late phenomenon. In epithelioma, ulceration is an early occurrence and the lymph glands are usually involved at an early stage. As with these growths in other situations we find sarcoma in the young as well as the old, while epithelioma is met with at, or after, middle life. In many cases no cause is discoverable while in others a distinct source of irritation, either in occupation or habits, is ascribed as a cause. Syphilis may be admitted as an etiological factor while the influence of heredity is accepted by many observers.

The pain in malignant disease, if not more severe, is more lasting than that of any other form of tonsillar disease and, in many cases, it is intense and extends to the ear of the side affected. Impediment to phonation and deglutition is dependent upon the dimensions of the tumor, or the degree of ulceration. The color of a sarcoma is generally paler than that of adjacent parts and until ulceration takes place the tumor is symmetrical in contour.

An epithelioma is usually warty and irregular. Frequently the excrescences which compose it are quite pallid. After the establishment of ulceration a thin and very offensive secretion is formed and there is a constant desire to clear the fauces. The appearance of cachexia is earlier and more pronounced in epithelioma than in sarcoma. Not uncommonly a syphilitic taint complicates the cancerous lesion and, in many cases, it becomes necessary to differentiate the two diseases. In syphilis swallowing may be difficult and somewhat painful. In cancer there is marked odynphagia and spontaneous acute pain is almost continual. Syphilitic lesions of the tonsil are usually either superficial in the form of mucous patches, or occur later as deep destructive ulcerations, somewhat resembling cancer. A gummatous infiltration of the tonsil before the stage of softening looks more like sarcoma. In cancer

there is always a neoplasm which ultimately breaks down. In syphilis there is a moderate amount of lymphadenitis which on examination is found to be general. In cancer only the neighboring lymphatic glands are indurated and they are painful, or sensitive. Hemorrhage in syphilis is rare while in cancer it is frequent and free. The absence of cachexia in the former and its presence in malignant disease at an early stage may be determined. A microscopic examination usually settles any question as regards epithelioma, but in sarcoma is somewhat less conclusive. In many cases the early symptoms simulate so closely those of simple hypertrophy of the tonsil that amygdalotomy may be proposed and in several instances it has actually been done under this misapprehension. Such an error is excusable, but is not likely to occur if a digital examination discloses an unusual degree of induration. Moreover, unilateral enlargement of the tonsil should always suggest the possibility of syphilis, or a neoplasm. A tentative course of iodide of potash assists in removing doubt as to syphilis.

A most interesting case of tonsillar tumor first reported by Bryson Delavan as a tertiary ulceration simulating sarcoma illustrates how the microscope at times fails to clear up a doubtful clinical diagnosis. After two months of soreness and swelling of the tonsil a deep ulcer with sloughy base and everted edges formed, the body of the gland being indurated. There was some pain on swallowing and the cervical glands were slightly enlarged. The mass was removed with the cold-wire snare and sections were examined by several pathologists, some of whom pronounced it sarcoma while others were in doubt. The slow development of the tumor and the presence in the microscopic sections of an extraordinary number of endothelial cells led to the adoption of a diagnosis of syphilis. Iodide of potash was given continuously. One year later the tumor was as large as ever, was quite hard, and was adherent to the pillars of the fauces without infiltrating adjacent tissue. It was somewhat nodular but was not ulcerated. A few of the cervical glands were indurated. The neoplasm was dissected out under ether by R. P. Lincoln, who placed sections in the hands of several experts. They agreed in excluding malignant disease, but were divided between syphilis and simple inflammatory hyperplasia. Eighteen months later there had been no recurrence.

In several cases noted by Newman and others malignant degeneration of an old syphilitic gumma has been observed.

The prognosis in malignant disease is, of course, extremely unfavorable.

In the early stages the disease may be retarded by removal of the primary lesion together with the affected glands. It is hardly ever

possible to reach it through the mouth. Extensive incisions in the neck with division of the upper jaw for exposure and extirpation of infiltrated glands, as well as of the primary lesion, are required. A preliminary tracheotomy is not essential. A radical operation of this kind is justifiable with a view to prolonging life and in the hope that recurrence may take place in a region where less suffering may be imposed upon the patient. The round-celled sarcoma, or lymphosarcoma is especially virulent and according to David Newman "it is a malady in which, even from the onset, little hope can be entertained of saving the patient." Early operation in epithelioma gives a somewhat better chance, but the chief difficulty, as pointed out by Butlin, lies in the intimate relation between the pharyngeal structures and the cervical lymphatics, so that dissemination of the disease takes place promptly. Yet in several cases of the spindle-celled variety of sarcoma the tumor was found to be enclosed by a capsule from which it was actually shelled out. Electrolysis, cataphoresis, or the injection of toxins after the method recommended by W. B. Coley seem to offer some hope of success, at least in sarcoma. More than 100 cases treated with the mixed toxins of erysipelas and the bacillus prodigiosus are recorded as successful. All were sarcoma in some form except six—three endothelioma and three epithelioma—and in all but twenty the diagnosis was verified by the microscope. These results certainly entitle the method to respectful consideration both in inoperable cases and as a prophylactic against recurrence after operation. In the majority of cases we are dependent upon palliatives for the relief of pain. The application of cocaine to the diseased or ulcerated surface, insufflation of orthoform, and the hypodermic injection of morphine give temporary amelioration.

TUBERCULOSIS OF THE PHARYNX.

In spite of the fact that the bacillus is supposed to be capable of entering the system through intact epithelium and that it is frequently found in the air tract of perfectly healthy people, authentic cases of tuberculosis affecting the structures of the pharynx are very few. As a rule, in this situation it is secondary to pulmonary disease or coincident with it; or it may occur as a sequel to tuberculous disease of the cervical vertebræ. Primary cases have been reported

but there is always a suspicion that a deep-seated or limited lesion in the lung has escaped detection. In a case of my own a deep ulcer involving the right side of the base of the tongue was diagnosed as carcinoma and the whole tongue was excised. There were no signs of pulmonary disease at the time and none appeared subsequently.

The diagnosis is often difficult either because of the absence of significant appearances in the lesion itself or because of the existence of a mixed infection, the condition being masked by certain phenomena due to syphilis. In a typical case of disseminated miliary tuberculosis the character of the lesion is sufficiently clear; the nibbled, irregular margins of the ulcer permit of little chance of confusion with the deep, clean-cut ulceration of syphilis. Moreover, a bacterial examination will generally discover the bacillus either in the secretions or the tissue itself. The tubercular deposit may involve the tonsil, the velum, or any part of the pharyngeal wall. Associated with the local lesion we usually find more or less pronounced cervical lymphadenitis.

The early symptoms are those of subacute inflammation and their real character may not be suspected in the absence of physical signs in the lung. At the outset considerable swelling is observed, followed by the formation of yellowish spots of miliary tubercle which, after a time, soften and form small ulcers, usually round and superficial, covered by a grayish secretion and surrounded by pale mucous membrane. Thus several independent foci of ulceration develop giving the tissues a so-called *worm-eaten* appearance. Indications of an attempt at spontaneous repair are observed at some points but the cicatrices are prone to break down.

Pain is generally pronounced and aggravated by swallowing until deglutition becomes impossible, or the patient may complain merely of sensations of dryness and heat. The voice is affected either by more or less involvement of the larynx or by accumulation of secretion the expulsion of which the patient dreads to attempt. The breath is fetid. There is a dry cough, or expectoration is free if the lungs are involved. The usual general symptoms of tuberculosis sooner or later present themselves.

The prognosis is necessarily bad both because a lesion in this situation is indicative of a severe type of disease and because of the interference with nutrition owing to dysphagia.

The treatment is that of general tuberculosis and, in addition, certain local applications give good results in primary cases and in those not complicated by extensive pulmonary or laryngeal disease. In any case we are called upon to adopt measures for the relief of pain. An ulcerative process favorably located may be treated by curetting and lactic acid, followed by insufflation of iodoform and orthoform which together seem to produce anesthesia and promote cicatrization. The use of pineapple juice as a spray or a gargle is recommended by some as a detergent and mild astrigent as well as for the relief of pain. Spraying with a solution of suprarenal capsule is somewhat effective in the mitigation of irritability, and in extreme cases the local use of cocaine and of morphine internally is required. Suitable climatic conditions and the usual constitutional remedies are indicated.

Odynphagia in this disease as well as in some cases of tuberculosis of the larynx often demands first attention. The pain in swallowing is so extreme that the patient finally gives up attempting to eat. The natural result is a rapid decline in strength and vitality. In the majority of these cases nothing has been found to equal orthoform as a local sedative. Cocaine enables the patient to swallow with comparative comfort but is often objectionable on account of the paresthesia it excites. An excellent mode of administration is in the form of a lozenge containing one quarter of a grain of orthoform, one or two to be dissolved in the mouth ten or fifteen minutes before food is taken. Thus we are enabled to employ one of our most valuable resources, namely hypernutrition, in combating the inroads of tuberculosis.

LUPUS OF THE PHARYNX.

Lupus of the pharynx in some respects resembles tuberculosis, but exhibits several important points of distinction. The pain and constitutional disturbance met with in the latter are quite absent. The evidence that lupus is a modified form of tuberculosis and that most patients affected with the former die of tuberculosis does not seem to be wholly sufficient. Moreover, the presence of tubercle bacilli in a lupoid lesion has not yet been clearly demonstrated. It is very slowly progressive and is not attended by severe subjective symptoms. The function of the pharyngeal structures is interfered

with if the velum or the epiglottis is involved owing to thickening from infiltration, destructive ulceration, or cicatricial bands. The affected region presents a granular appearance in the shape of small nodules, soft, insensitive, non-vascular, and in color differing but slightly from the surrounding mucous membrane. There may be considerable destruction of tissue and the resulting deformity from cicatrization, if repair takes place, is very marked.

In many cases the process is mistaken for syphilis but the history of the case, the superficial character of the ulceration and its rapid cicatrization independent of special treatment, should establish the diagnosis. Glandular involvement is rather rare in lupus, whereas a general lymphadenitis is almost invariable in syphilis. Tentative treatment may be misleading for the reason that strumous conditions, under which lupus is sometimes classed, are often benefited by alterative medication, while some cases of syphilis offer obstinate resistance to specific remedies.

The majority of cases terminate fatally, but some cures are recorded as a result of thorough ablation of diseased tissue and cauterization. Tonics and careful nutrition are no less important.

In a case under my observation many years ago in the service of Dr. Asch at the New York Eye and Ear Infirmary, the disease involved the entire velum and thence extended to the larynx. It gradually yielded with moderate deformity under persistent applications of saturated solution of silver nitrate and Fowler's solution internally, and later perchloride of iron locally, two drachms to the ounce, combined with the internal use of iron and cod-liver oil. In this case the duration of the disease, from the beginning of treatment to the time when a cure was pronounced, was upward of two years.

SYPHILIS OF THE PHARYNX.

Manifestations of syphilis are met with in the pharynx at any stage of the disease, either independently or coincident with cutaneous eruption.

The primary sore, or *hard chancre*, has been observed many times upon the tonsil and sometimes presents appearances which permit of its easy recognition. The first symptom is a sore throat, aggravated by pain in swallowing, which does not yield to ordinary treatment. The affected tonsil is considerably enlarged and very early the

nearest lymphatic glands become indurated. The ulcer itself is somewhat granular, grayish in color and implanted upon more or less induration. Its surface is usually level with the surrounding parts. In the course of two to six weeks a confirmatory secondary syphiloderma may be expected. According to Rhodes we must usually wait for this episode before venturing on a certain diagnosis. A superficial ulcer seated upon an indurated tonsil, rebellious to local treatment and accompanied by enlarged cervical glands is merely suspicious until an eruption appears. *Erythema* of the fauces in syphilis is apt to develop in connection with a roseola of the skin and differs from a simple acute erythema in being less intensely red, comparatively free from swelling and sensitiveness, and limited by a distinct line of demarcation at the junction of the soft with the hard palate. The erythema may invade the tonsils and the pharyngeal membrane generally.

The most common and obstinate and most dangerous, because highly contagious, lesion of syphilis of the air passages is the *mucous patch*. Although classified as a secondary lesion it may be met with early or late in the course of the disease. It is most apt to occur in conjunction with a papillary syphiloderma, but is more persistent than the cutaneous lesion. Mucous patches seldom give rise to decided subjective symptoms, although they are slightly sensitive to condiments, acids and hot or cold drinks. When the patches coalesce and cover a large area they are decidedly painful. In its early stages a mucous patch looks like a small opalescent erosion of the mucous membrane, resembling a surface that has been touched with nitrate of silver. There is seldom any induration except in patches of long standing; in the latter case, several may coalesce and form a considerable ulcerated surface which projects more or less above the surrounding membrane. In the folds of mucous membrane it is not uncommon to see them presenting a distinctly fungating appearance resembling condylomata.

While these patches are very rebellious to treatment in some cases and show a persistent tendency to recurrence, in others they disappear promptly under superficial cauterization. Ordinarily there is no extensive or deep destruction of tissue, but when the patch has been exposed to prolonged irritation there may be a good deal of breaking down, resulting in true ulceration. When this state of things has developed, the suffering of the patient is consider-

able even to the degree of interfering with proper nutrition. This is especially the case when the soft palate is involved or the parts employed in the act of deglutition are affected (Fig. 108).

Most of the ulcerating processes met with in syphilis are due to a breaking down of gummatous infiltration and are presented in

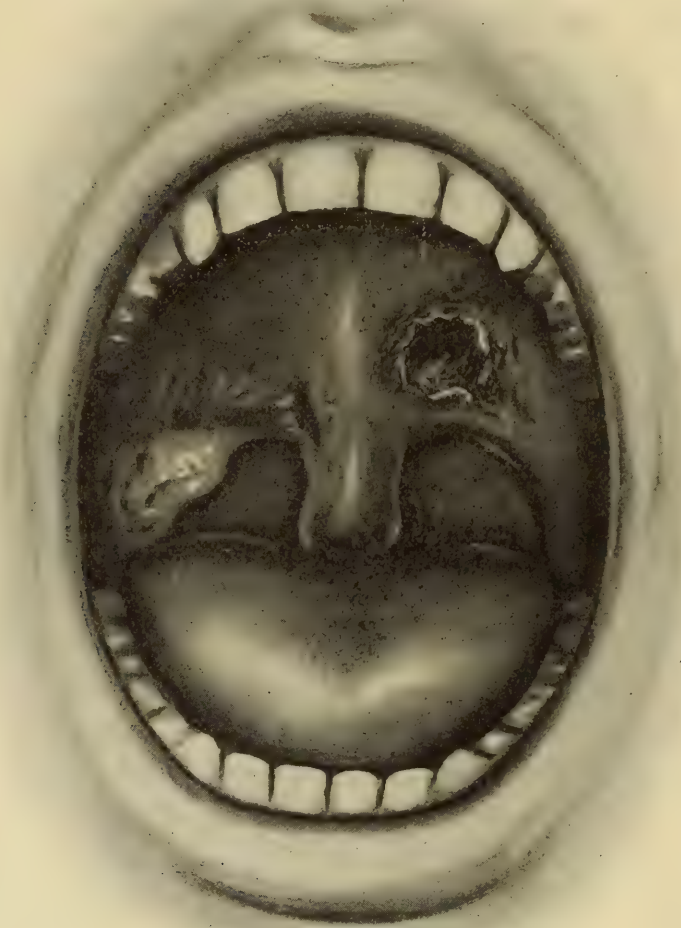


FIG. 108.—Syphilitic Ulcer of Right Pillar with Perforation of Velum on Left Side.
(*De Blois.*)

two forms, superficial and deep. This division is purely an arbitrary one and the course pursued in each case is the same; namely, in the first place, a distinct induration which presently undergoes softening with rupture of the overlying mucosa and the formation of an excavated ulcer of greater or less depth in proportion to the degree of infiltration. This manifestation of syphilis may be met with at almost any part of the pharyngeal wall and is

productive of those deforming and disabling cicatrices which are so familiar. A gummatous process in the mucous membrane is exceedingly insidious and extensive damage may be done before the importance of the condition is appreciated. (Fig. 109).

One of the most intractable conditions which we are called upon

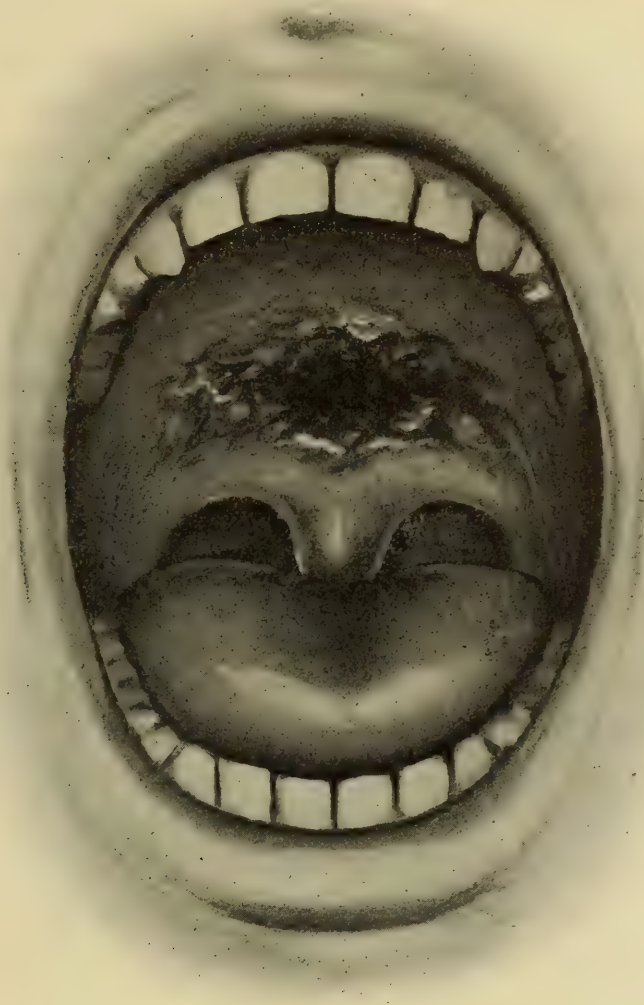


FIG. 109.—Extensive Perforation of Velum in Syphilis. (*De Blois.*)

to correct is that of adhesion between the velum and the posterior pharyngeal wall resulting from this process.

Recognition of an ulcer due to disintegration of gummy infiltration is usually free from difficulty. The edges are sharply cut, surrounded by a well defined areola and the surface of the ulcer is more or less excavated and covered with purulent secretion and shreds of slough. In the early stages, however, before necrosis has taken place identification of the condition is less easy and many cases are

recorded in which a softening gummy tumor has been mistaken for simple abscess and has been uselessly subjected to the knife.

No lesions in the upper air tract respond more promptly to suitable treatment than syphilitic manifestations, except those occurring in so-called malignant syphilis or in individuals in depressed general health, and in those who persistently neglect treatment or violate hygienic laws. The treatment should be in line with that of syphilis in general, supplemented by certain local applications in some cases. The chancre usually requires no attention beyond the use of an antiseptic gargle or, if it is very sensitive, the occasional application of a local anesthetic like cocaine. A similar statement applies to erythema of the pharynx.

The mucous patch, on the other hand, requires more careful attention on account of its contagiousness and for the additional reason that if allowed to persist it is apt to extend over more surface and to greater depth. All irritants, in the first place, such as alcohol, tobacco and highly seasoned food, should be abandoned. Gargling with an alkaline solution, especially after eating, will be found soothing and is usually effective. Repair of the patch in refractory cases is expedited by careful application to its surface every second or third day of the solid stick of nitrate of silver. The gummy tumor, before softening has ensued, is usually speedily dissipated by rapidly increasing doses of iodide of potassium. When ulceration has taken place necrotic tissue must be removed, the surface of the ulcer kept clean, and occasionally cauterized with nitrate of silver; at the same time the internal treatment being vigorously pushed. In many cases the action of the iodide should be aided by mercurials, either in the form of inunctions or internally and, in many cases, recovery is assisted by the use of tonics. Attention to hygiene, diet and exercise is quite as important as drug-giving.

The contractions which result from syphilitic ulceration are frequently incurable. The cicatrices are usually characteristic. When adhesion of the velum to the pharyngeal wall is complete the patient is able to get his supply of air only through the mouth and, in consequence, the act of eating is seriously impeded. It is very important, therefore, to restore the normal air tract. In some cases this is to a certain degree feasible; in others the nasopharyngeal cavity is obliterated by adventitious bands to such an extent that its restoration is quite impracticable. The tendency

to reformation of adhesions after their division is always very marked. To obviate this many devices have been proposed such as the passage of a strip of lint through the nose which is allowed to fall between the velum and the wall of the pharynx. A plate of lead or of gutta-percha suspended in the pharynx by threads passed through the nares has accomplished the object. In several cases under my own care the patient was provided with a set of dilators of various sizes by which the opening was kept free; but readhesion or contraction took place when systematic dilatation was suspended. When the adhesions are very thin and involve simply the margin of the velum a proposal made by Andrew H. Smith to cauterize the raw surfaces, after division, with monochloracetic acid has been successful, the slough caused by this acid being retained long enough to allow the formation of protecting granulations. Various ingenious plastic operations have been designed for removing the adhesions, some of which have been partially successful. Several cases operated upon by the late J. E. Nichols resulted very favorably. By his method a perforation of the velum is made on either side as far from the middle line as possible. Through these perforations setons are passed and worn for many weeks or until cicatrization around them is complete. The perforations are then joined by incisions carried from side to side between them, thus releasing the velum. A plate of gutta-percha or vulcanite is worn suspended from the nostrils to keep the fresh surfaces apart until repair is complete. Although by these various methods we succeed in fairly restoring the air tract the damage to the structure of the velum is often irreparable. It is surprising how difficulty in swallowing and defects of speech may be overcome in course of time and by the exercise of care, provided there has been no great loss of tissue. In cases of excessive destruction of palatal tissue the only resource is the adjustment of an obturator, or artificial palate.

NEUROSES OF THE PHARYNX.

Anesthesia is occasionally met with in the pharynx as a result of specific disease and of diphtheria. It has been observed in hysteria, in epilepsy and in general paralysis of the insane. As a result of progressive bulbar paralysis it is a much more serious condition than in the other diseases mentioned. It may be induced temporarily by morphine or the bromides.

Treatment is seldom if ever necessary and in the presence of a grave central nerve lesion is unavailing.

Hyperesthesia of the pharynx occurs in acute inflammations and in those addicted to the excessive use of stimulants and tobacco, or it may be a manifestation of hysteria. It is frequently a serious obstacle to successful examination of the upper air passages, and is sometimes overcome by the administration of bromides, by the local use of cocaine, or by sucking of ice.

Paresthesia, in which abnormal sensations, as burning, pricking, or itching, are complained of, is peculiar to hysterical females and neurotic subjects. An exciting cause is frequently discovered in certain enlarged follicles of the pharynx or the base of the tongue, the destruction of which results in cure. When the perverted sensation amounts to pain we recognize a distinct neuralgia of the pharynx, the treatment of which depends upon its cause but which usually yields to local sedative applications. In hay fever a very persistent and annoying itching in the pharynx and in the roof of the mouth is often present.

Spasm of the pharyngeal muscles occurs in various conditions such as hysteria, epilepsy, and in certain cerebral diseases. Clonic spasm, especially of the levator palati muscle, may be seen in connection with facial spasm or with a general chorea. Spasm of the pharyngeal constrictors has been traced in several cases to cerebral tumor. Faucial spasm may be symptomatic of an acute inflammatory condition, or it may occur in the course of hydrophobia.

Paralysis of the pharynx is very frequently observed as a sequel of diphtheria or from disease of a central area in the medulla. It is one of the earliest symptoms of progressive bulbar paralysis. Involvement of the soft palate is attended by forcing of food into the nasopharynx during attempts at swallowing and when paralysis of the glottis coexists fluids and food may invade the larynx and trachea. In bulbar paralysis other symptoms characteristic of the disease are more prominent and the prognosis is generally fatal. When occurring as a sequel of diphtheria or in connection with facial paralysis the prognosis is much more favorable and recovery takes place without the adoption of any special line of treatment, but it may be expedited by the use of tonics internally, strychnia and the local application of galvanism. In so-called myopathic paralysis a muscle, or group of muscles, is supposed to be impeded in action

by infiltration with inflammatory products, the nerve supply not being primarily affected. Such conditions are rare but may follow simple inflammatory conditions as in cases reported by the author and others.

Foreign bodies in the pharynx are usually sharp-pointed articles, such as fish-bones, pins, or sharp spiculæ of bone. Objects with smooth surfaces pass on, as a rule, into the esophagus or into the larynx. Symptoms are often very misleading, as the erosion of the surface which it causes generally induces a sensation as though the foreign body were still present. A sharp body, such as a needle, frequently pierces the tissues and thence migrates to another part. It is often a very difficult matter to locate a foreign body in a nervous patient or when it has been long *in situ* and has excited irritability and inflammation.

By the use of the laryngeal mirror, the parts having been anesthetized with cocaine if necessary, the object is discovered perhaps imbedded in the follicle of a tonsil or of one of the glands at the base of the tongue or lying in the hyoid fossa. Inspection of the parts is, with advantage, supplemented by digital examination and sometimes extraction may be effected by means of cotton wound on a probe, or upon the finger. In most cases the use of the forceps will be necessary. If left alone a small object may become encysted and do no further damage. On the other hand, hemorrhage may follow penetration of a blood-vessel, or sepsis may ensue from the development of phlegmonous inflammation. When a large irregular body becomes impacted in the lower pharynx its removal by external pharyngotomy may be required. The necessity for a resort to external operation will disappear with improvement in the technic of pharyngoscopy. A most interesting case is described by T. H. Halsted in which he removed with a Jackson instrument a penny which had been embedded for four and a half years in the posterior wall of the esophagus at its lower end. The symptoms had been ascribed to a congenital stricture, but the presence of a foreign body was definitely located at about one inch from the cardiac orifice of the stomach by means of the X-ray. The latter diagnostic resource and the clearness with which the parts are illuminated with the light at the distal end of the Jackson tube have added greatly to the accuracy and safety of manipulations in these regions. (p. 386.)

THE LARYNX.

CHAPTER XVII.

ANATOMY AND PHYSIOLOGY OF THE LARYNX. METHODS OF EXAMINATION.

ANATOMY AND PHYSIOLOGY.

The larynx, or "voice box," is composed of two large cartilages, the thyroid, or shield cartilage, the cricoid, or ring cartilage, and a third somewhat smaller, the epiglottis, a leaf-like lid or valve which aids in diverting ingesta from the chink of the glottis. In addition to these single cartilages there are six smaller ones arranged in pairs, the arytenoid, the cornicula laryngis (Santorini) and the cuneiform (Wrisberg). All are closely bound together by ligaments, membranes and muscles.

The cricoid, the foundation cartilage of the larynx; is attached below to the first ring of the trachea and articulates above with the thyroid. It is thicker and heavier posteriorly, where it supports the arytenoid cartilages, the latter being surmounted by the cartilages of Santorini, or cornicula laryngis, and the cartilages of Wrisberg, or cuneiform cartilages. The last three are called the cartilages of motion, because they are especially concerned in the movements of the vocal bands.

The thyroid cartilage consists of two alæ, united in front at an angle of 80 to 90 degrees to form the *pomum Adami*. Each ala is nearly square and has extending upward and downward from its posterior border the superior and inferior cornua, the former being attached to the hyoid bone by the thyrohyoid ligament, the latter articulating with a facet on the side of the cricoid cartilage.

The arytenoid cartilages articulate with facets on the upper border of the cricoid, are triangular in shape on cross section and give attachment to all the intrinsic muscles of the larynx except the cricothyroid. The anterior angle of each arytenoid is prolonged at its junction with the vocal band and is called the vocal process. It is plainly visible in the laryngeal mirror. The cornicula laryngis sur-

mount the apices of the arytenoids, projecting backward and inward. The cuneiform cartilages are buried in the aryepiglottic folds in front of the cornicula.

The thyroid and cricoid, which consist wholly of hyaline cartilage, and the arytenoids, which are hyaline except at their summits, are prone to calcify in advanced life. The others, yellow elastic cartilages, show no such tendency. In addition to those mentioned several insignificant sesamoid cartilages are sometimes met with in the larynx. They are very inconstant and when present are of no importance.

The cricoid and thyroid cartilages are united in front and at the sides by the cricothyroid membrane, and the thyroid is joined above to the hyoid bone by means of the thyrohyoid membrane and ligaments.

The larynx is bound to the first ring of the trachea by the crico-tracheal membrane. The posterior wall of the larynx is held in position by various muscles and is in relation with the anterior wall of the laryngopharynx.

The epiglottis, a leaf-like plate of yellow elastic cartilage, is attached to the angle of the thyroid below its median notch. It varies much in size and shape, is somewhat depressed and folded laterally upon itself during deglutition, and is joined to the base of the tongue by three bands known as the median and lateral glosso-epiglottidean folds. It is fixed to the hyoid bone by a membrane called the hyo-epiglottic ligament; and from its base pass two bands of membrane which form the lateral boundaries of the superior aperture of the glottis known as the aryteno-epiglottidean folds.

The thyrohyoid membrane is composed of elastic fibers uniting the hyoid bone with the upper margin of the thyroid cartilage and is bounded laterally by the thyroid ligaments which pass from the superior cornua of the thyroid to the greater cornua of the hyoid. This membrane is pierced by the superior laryngeal nerve and arteries.

The cricothyroid membrane is subcutaneous at its middle portion and laterally is overlapped by the cricothyroid muscle. It is crossed by a small communicating branch between the two superior laryngeal arteries, known as the inferior laryngeal or cricothyroid. Two or three small vessels penetrate the membrane and supply the mucous membrane of the larynx.

The lateral portions of the cricothyroid membrane pass upward from the inner border of the cricoid and form the inferior thyroarytenoid ligaments, or true vocal bands, extending from the vocal process of the arytenoid cartilages to the angle of the thyroid cartilage near its center. These bands are covered by the thyroarytenoid and lateral cricoarytenoid muscles.

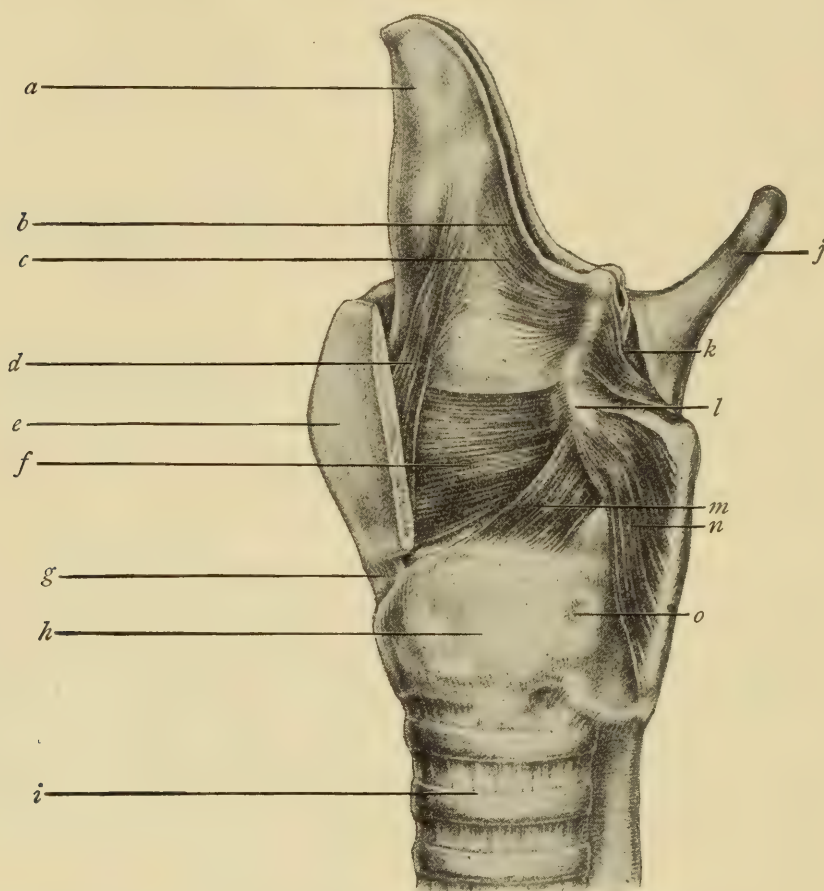


FIG. 110.—Muscles of Larynx, Lateral View. (*Deaver.*)

a, epiglottis; *b*, aryepiglottic fold; *c*, aryepiglottic muscle; *d*, thyroepiglottic muscle; *e*, thyroid cartilage; *f*, thyroarytenoid muscle; *g*, cricothyroid membrane; *h*, cricoid cartilage; *i*, trachea; *j*, superior cornu of thyroid cartilage; *k*, arytenoid muscle; *l*, muscular process of arytenoid cartilage; *m*, lateral cricoarytenoid muscle; *n*, posterior cricoarytenoid muscle; *o*, facet for articulation with thyroid cartilage.

The superior thyroarytenoid ligaments, ventricular bands, or false vocal bands, consist of fibrous tissue extending antero-posteriorly just above the true vocal bands. Muscular fibers within their folds are described by some anatomists as the superior or external thyroarytenoid muscles. They assist the inferior thyroarytenoids (Fig. 110).

The muscles controlling the movements of the laryngeal cartilages are divided into two groups, extrinsic and intrinsic. The extrinsic are the sternothyroid, the thyrohyoid, the stylo- and palato-pharyngeus and the inferior constrictor of the pharynx. Of the intrinsic muscles the cricothyroid is attached to the front and side of the cricoid and to the lower border of the thyroid cartilage. The lower

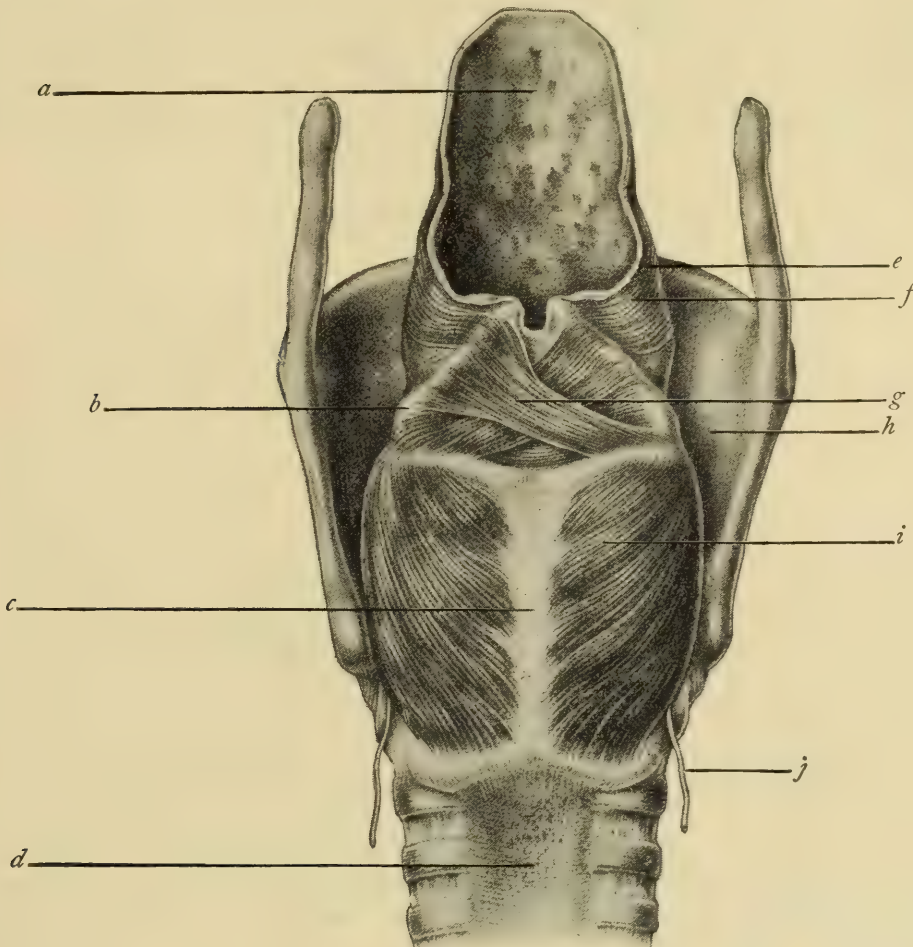


FIG. III.—Muscles of Larynx, Posterior View. (*Deaver.*)

a, laryngeal surface of epiglottis; *b*, muscular process of arytenoid cartilage; *c*, cricoid cartilage; *d*, trachea; *e*, aryepiglottic fold; *f*, aryepiglottic muscle; *g*, arytenoid muscle; *h*, thyroid cartilage; *i*, posterior crico-arytenoid muscle; *j*, recurrent laryngeal nerve.

fibers pass to the border of the inferior cornua and act by pulling the cricoid directly backward while the spreading fibers which form the rest of the muscle swing the cricoid upon the cricothyroid joints, pulling it backward as well as upward. Some anatomists erroneously describe the swinging or tilting movement as taking place in the thyroid rather than the cricoid, but most authorities agree that the

origin and fixed point of the cricothyroid muscle are upon the thyroid cartilage and that therefore the posterior are the movable ends of the vocal bands. For this reason Jurasz advocates calling the muscle "thyrocricoid" instead of cricothyroid. The practical effect, stretching of the vocal bands, is the same in either case. This muscle is a tensor of the vocal bands (Fig. 111).

The posterior cricoarytenoid muscle arises from the cricoid cartilage and is inserted into the outer angle or muscular process of the arytenoid cartilage. Its upper fibers rotate the arytenoid whilst the lower fibers pull the whole mass of the arytenoid outward. It

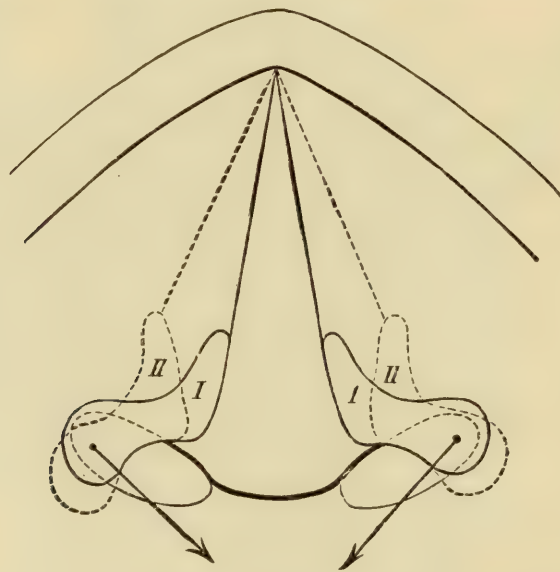


FIG. 112.—Scheme of Action of Posterior Cricothyroid Muscles.
(Landois and Stirling.)

is, therefore, a dilator of the glottis, or abductor of the vocal bands (Fig. 112).

The lateral cricoarytenoid muscle springs from the upper border of the cricoid between the origin of the cricothyroid and the cricoarytenoid articulation, and is inserted into the forepart of the muscular process of the arytenoid. It rotates the cartilage inward and draws it forward, relaxing and approximating the cords.

The thyroarytenoid muscle arises from the lower two-thirds of the inner surface of the thyroid close to its angle and slightly from the cricothyroid membrane. It passes outward and backward and is inserted into the anterior surface of the arytenoid cartilage and to its base close to the attachment of the lateral cricoarytenoid muscle. The lower and inner portion is parallel with and blends with

the vocal band. The upper and outer portion is placed immediately beneath the mucous membrane and overlies the ventricle. These two divisions of the muscle are sometimes known respectively as the inferior, or internal, and the superior, or external thyroarytenoids (Fig. 113).

These muscles rotate the arytenoids and draw the vocal bands downward and inward and thus approximate them. At the same time they relax the vocal bands as a whole. Some fibers attached to the free border of the vocal band are said to be capable of making tense a portion only of the band, leaving the rest relaxed, thus re-

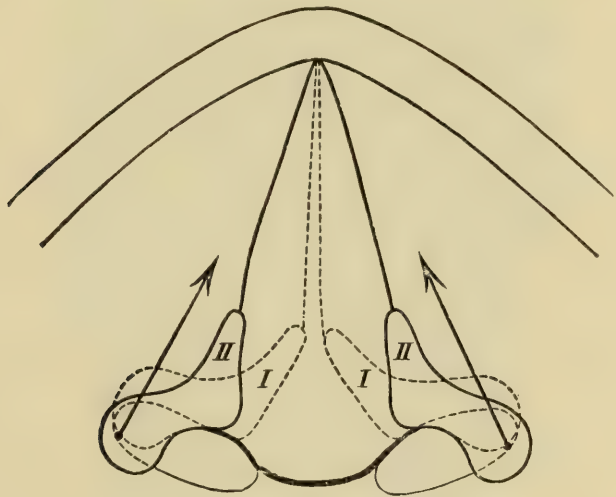


FIG. 113.—Scheme of Action of Thyroarytenoid Muscles. (*Landois and Stirling.*)

sembling somewhat the stop action of the finger on a violin string. They also make the band thinner and wider.

The arytenoideus muscle consists of transverse fibers passing across from one arytenoid cartilage to the other, and attached to their posterior surface. Superficially, oblique fibers pass from the base of one cartilage to the summit of the opposite cartilage. A few of the latter pass under the arytenoepiglottidean fold and side of the epiglottis, constituting the epiglottotoarytenoideus muscle. This muscle approximates and depresses the arytenoid cartilages (Fig. 114).

The thyroepiglottideus muscle, a part of the thyroarytenoideus, is composed of fibers which extend from the thyroid cartilage to the arytenoepiglottidean fold and the outer wall of the pharyngeal pouch and epiglottis.

The nerve supply of the larynx is derived from the laryngeal

nerves, superior and inferior. The superior has two branches. The external is distributed to the cricothyroid muscle and sends a few filaments to the mucous membrane of the larynx; it is chiefly a motor nerve. The internal branch is larger and is purely sensory. It pierces the thyrohyoid membrane and distributes branches to the epiglottis and to the mucous membrane of the larynx as far down as the true vocal bands.

The inferior, or recurrent, laryngeal nerve is the motor nerve of the larynx. It arises from the vagus at the root of the neck, winds from before backward around the arch of the aorta on the left side

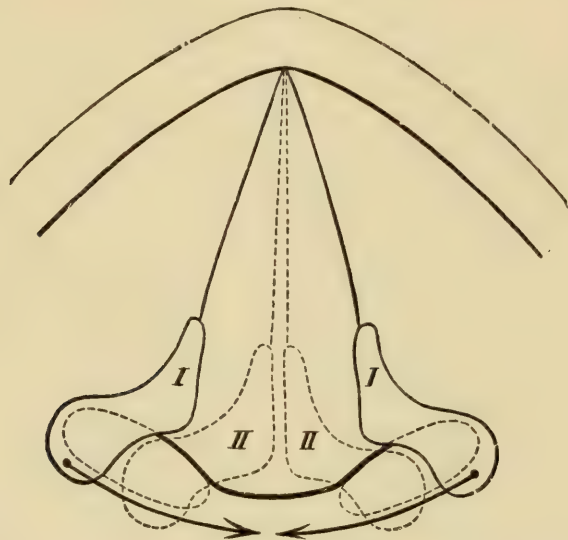


FIG. 114.—Scheme of Action of Arytenoideus Muscle.
(Landois and Stirling.)

and around the subclavian on the right, and then ascends between the trachea and the esophagus. It enters the larynx immediately behind the cricothyroid joint and divides into two branches, an anterior to the thyroarytenoideus, the cricoarytenoideus lateralis, and muscles of the epiglottis, and posterior branches to the posterior cricoarytenoideus and arytenoideus, and communicates with the superior laryngeal by slender filaments near the posterior border of the thyroid cartilage (Fig. 115).

The arterial supply is derived from the superior and inferior thyroid, the epiglottis receiving some branches from the dorsalis linguæ from the lingual.

The aperture of the glottis is triangular in shape, bounded in front by the epiglottis, behind by the arytenoid notch, and on either side

by the arytenoepiglottidean fold. Between these folds and the wings of the thyroid on either side is a depression known as the "pyriform sinus," or "fossa laryngo-pharyngea".

The cavity of the larynx is lined by mucous membrane, somewhat

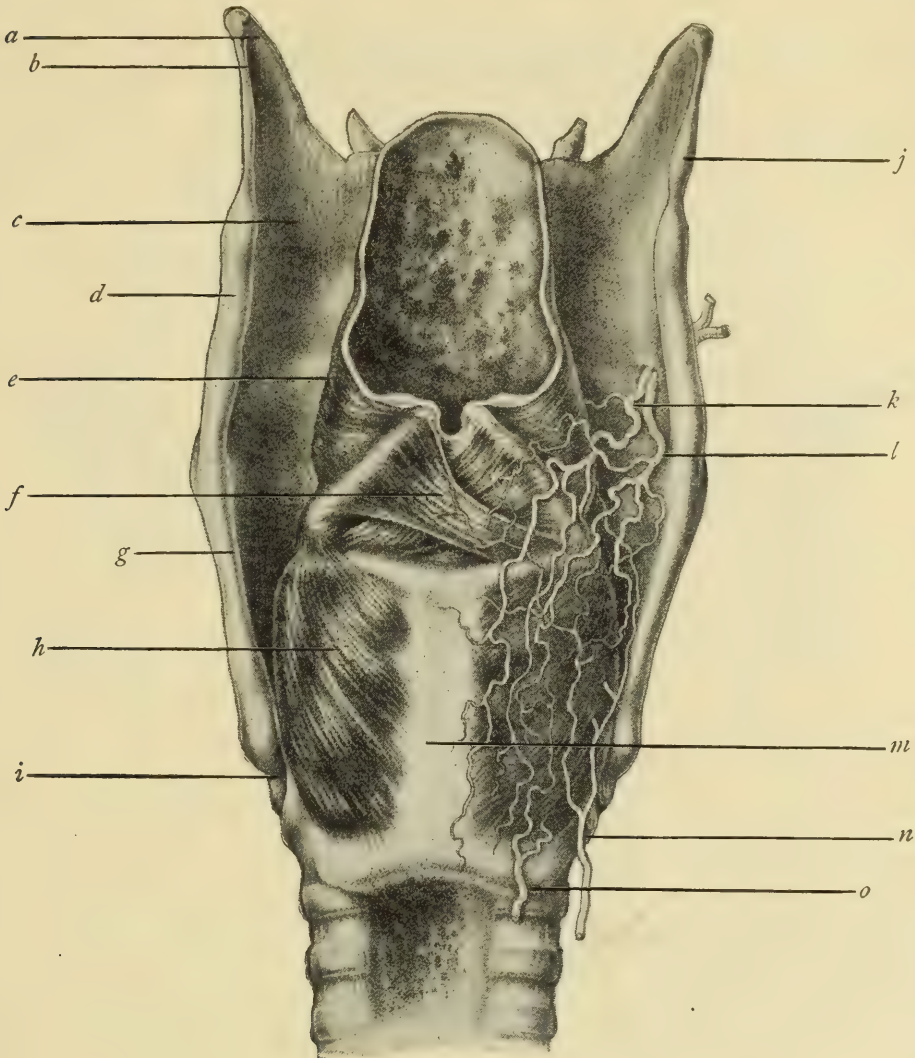


FIG. 115.—Nerves and Arteries of Larynx. (Deaver.)

a, greater cornu of hyoid bone; *b*, thyrohyoid ligament; *c*, thyrohyoid membrane; *d*, superior cornu of thyroid cartilage; *e*, aryepiglottic muscle; *f*, arytenoideus muscle; *g*, posterior border of thyroid cartilage; *h*, posterior cricoarytenoid muscle; *i*, cricothyroid articulation; *j*, cartilago tritacea; *k*, internal laryngeal nerve; *l*, superior laryngeal artery; *m*, cricoid cartilage; *n*, recurrent laryngeal nerve; *o*, inferior laryngeal artery.

thick and red in color except over the true vocal bands where it is pale, thin and adherent (Fig. 116). Numerous elastic fibers and mucous glands are found in the submucous tissue. The cavity is divided into two portions, the supra- and infrarimal, the true vocal bands being the line of separation. Immediately above each vocal

band lies the ventricle of the larynx, bounded above by the ventricular band, and externally by the thyroarytenoid muscle. It is lined by mucous membrane continuous with that of the larynx and from its anterior part, extending upward about one-half inch, is the laryngeal pouch, or "sacculus laryngis." Its mucous membrane contains many glands which supply secretion for lubricating the vocal cords. At its outer side are fibers of the thyroarytenoideus muscle, while on its inner side is an extension of muscular fibers of the arytenoepiglottideus known as Hilton's muscle or the *compressor sacculi laryngis*.

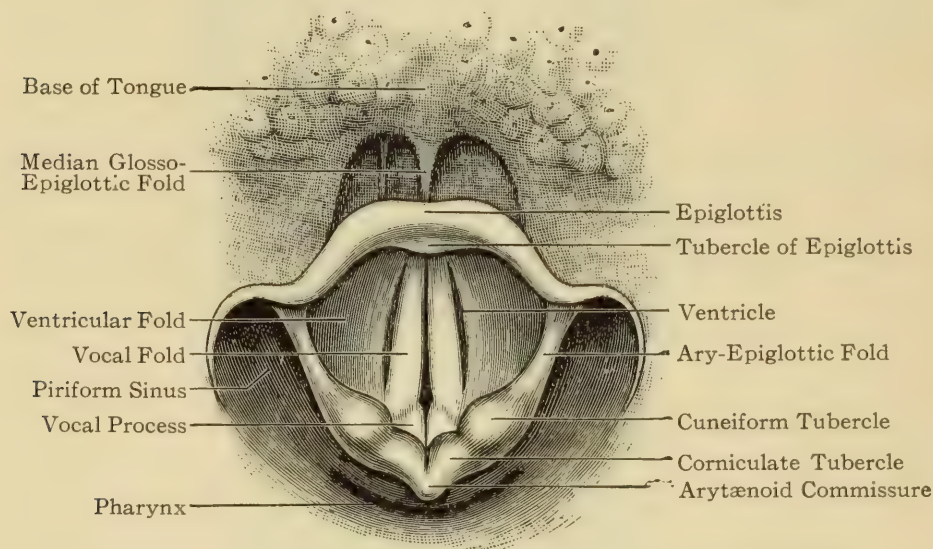


FIG. 116.—View of Interior of Larynx as seen during Vocalization. (Morris.)

The superior, or false vocal cords, or ventricular bands, stand further apart than the true vocal bands and between them and the arytenoepiglottic folds on either side is a shallow depression known as the *fossa innominata*. Their contour is full and round and they are covered by red, moist mucous membrane, while the true vocal bands are pearly white or opaline in appearance and present flattened surfaces as seen from above. On cross-section the latter are triangular, and strictly speaking are neither bands nor cords. Their average length in the adult is seven lines (14 mm.).

The rima glottidis, or triangular space between the vocal bands, is limited behind by the interarytenoid commissure, and in front by the thyroid cartilage. Its dimensions vary in respiration and phonation. The infrarimal portion becomes almost circular below the vocal bands and is continuous with the trachea (Fig. 117).

The larynx is spoken of as the organ of voice, and we are apt to lose sight of the important part played by other structures in voice formation until our attention is drawn to them by some defect in

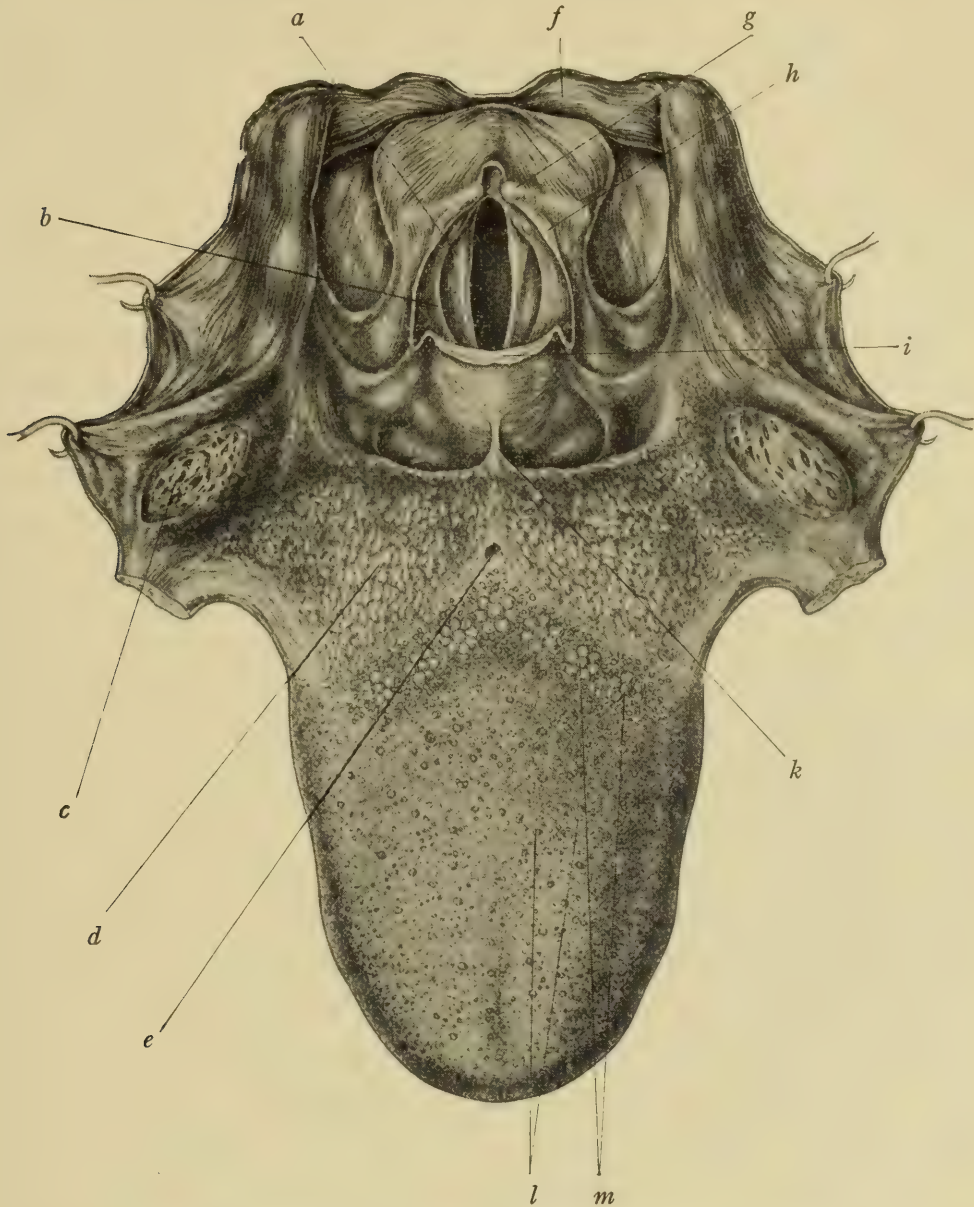


FIG. 117.—Superior Aperture of Larynx and Dorsum of Tongue. (*Deaver.*)

a, vocal band; *b*, ventricular band; *c*, tonsil; *d*, adenoid tissue at base of tongue; *e*, foramen cecum; *f*, posterior wall of pharynx; *g*, corniculum laryngis; *h*, cuneiform cartilage; *i*, epiglottis; *k*, median glosso-epiglottic fold; *l*, fungiform papillæ; *m*, circumvallate papillæ.

structure or function. The nasal chambers and the accessory sinuses, the lips, the teeth, the tongue, the velum and pillars of the fauces, the trachea and lungs, as well as the shape and size of the

larynx itself, all share in influencing the timbre and the pitch of the voice. The larynx is not even essential to audible and articulate speech, as has been shown in a famous case of complete laryngectomy in which the pharynx was entirely shut off from the lower air-tract, the patient learning to speak and even sing by sucking in and storing air in his pharyngeal pouch (Solis-Cohen). Similar facility was acquired by a patient wearing a trachea tube for complete obstruction of the larynx (Czermak) and by one also wearing a tube after an attempt at suicide by cutting his throat (Bourguet). The old idea that the epiglottis closes the larynx, like the lid of a box, during deglutition, has been supplanted by the view that it curls laterally in such a way as to direct the food into the pyriform sinuses (Carmalt Jones). In cases, in which the epiglottis has been absent, destroyed by disease, or removed, its duty has been assumed by the ventricular bands, and no impression has been observed, either upon swallowing or speech. It is not very movable, the larynx rather rising to meet it in the act of deglutition. The ventricular bands assist in protecting the larynx against the invasion of foreign substances, but are not concerned in normal voice production. It was once thought that in the formation of the falsetto voice they pressed down upon the vocal bands in such a way as to limit their vibration (Mandl), but this view is not capable of proof. They substitute for the true cords when the function of the latter is abolished. The vocal bands are not flat, but on cross-section are seen to be triangular or prismatic. Their free edges are composed of yellow elastic fibers by which their contour is preserved under varying degrees of tension. They are lubricated by secretion furnished by the mucous glands of the sacculus laryngitis, which opens into the ventricle of the larynx, the ventricle of Morgagni. A few mucous glands exist on the true cords. They are very numerous on the ventricular bands, and on the latter are also found irregular collections of lymphoid tissue, the "laryngeal tonsil." The color of the vocal bands is pearly white or opaline. They are about one-quarter of an inch shorter in the female than in the male, being about three-fourths of an inch long in the latter. Vocal sound is caused by impact of the expired air upon their free margins. The interesting mode of action of the thyroarytenoid muscles, of which the vocal bands are considered by some to be the tendinous portion, has already been described. The bands move slightly with respiration,

approaching each other on expiration and separating a little on inspiration, unless the latter be forced, when the reverse is true.

The aid of the extrinsic muscles, especially the sternothyroid, in securing efficient action of the intrinsic is essential, in order to fix the thyroid cartilage. The cricothyroid and thyroarytenoid muscles cannot come into full play without this preliminary fixation. Yet the abnormal use of the extrinsic muscles, as well as conscious or voluntary contraction of any of the laryngeal muscles, seems to be fatal to purity of tone and results in that disagreeable quality which is familiar to us as the "throaty" voice. The range of the speaking voice is very limited in most people and is modulated by infinite gradations. The tax upon the larynx in singing is much greater because a wide range is covered, sometimes more than two octaves, and moreover the utmost precision in striking the intervals, never less than a semitone, must be assured. When we consider the complicated and delicate mechanism of the larynx we appreciate the importance of favorable conditions, atmospheric and other, to the preservation and full development of the singing voice. Large demands are made upon the organism in general in vocal efforts of extraordinary character, hence the importance of maintaining the general health at a high standard if the best results are to be attained.

The hygienic value of exercises in voice culture, regardless of any special musical talent, cannot be too highly estimated. The majority of people, unaccustomed to athletic or outdoor sports, seldom if ever use their lungs to full capacity. The respiratory gymnastics, involved in well-directed vocal training, undoubtedly have a tendency to overcome a predisposition to pulmonary weakness and contribute to an improved vitality which enables one more successfully to resist disease in general. The local effect of such exercises, under intelligent guidance, is often marked in disappearance of small collections of hyperplasia in the mucous membrane of the air tract, or even on the vocal bands themselves, and in correction of a tendency to inflammatory outbreaks. The relation of nasal and pharyngeal anomalies to functional and ultimately structural derangements of the larynx has been already discussed.

Aphonia, or loss of voice, and dysphonia, or hoarseness, are symptoms of various diseases to be considered. Anything which interferes with the mobility, or elasticity, of the vocal bands acts as a cause. Similar results follow inflammatory, or obstructive, lesions else-

where in the air tract, the bands themselves remaining unimpaired. The causes affecting the vocal bands are divided into inflammatory, muscular, arthritic, and neurotic. As an example of the first the voice of a laryngitis may be mentioned. In acute laryngitis it is entirely lost; in chronic laryngitis it is whispering, or raucous. In rheumatic laryngitis the muscles are crippled, or there is anchylosis of the cricoarytenoid joint. In either case approximation of the vocal cords is difficult or impossible. Illustrations of neurotic aphonia are met with in hysteria, which is purely functional, and in disturbed innervation from pressure of an aortic aneurysm on the recurrent nerve.

The vocal bands resemble the reed of a wind instrument only in the fact that their margins vibrate under the influence of the passing column of air. The character of the voice is infinitely diversified by elongation and shortening, widening and narrowing of the bands constantly taking place in the production of different tones. The extraordinary combination of actions distinguishes the natural larynx absolutely from every possible artificial mechanism. When we consider how manifold are the elements concerned we begin to realize what a complicated process vocalization is and how futile must be any attempt to formulate a theory of voice culture universally applicable.

The shape and dimensions of the resonating cavities, a normal construction and healthy action of all parts of the vocal apparatus, even the texture of the tissue themselves, and more than all the musical intelligence and temperament of the individual participate in the formation of a voice of satisfactory power and pleasing quality.

METHODS OF EXAMINATION.

In laryngoscopy, or examination of the larynx, the position of the patient, and the source of light are similar to those in examining the nose and pharynx. The only additional instrument is a large-sized mirror to be introduced into the fauces with its reflecting surface downward. It is a good plan always to begin examinations of the larynx with the tongue at rest in the floor of the mouth; then, to depress it by means of a tongue-spatula; and finally, to support the protruded tongue between the thumb and finger. The laryngeal mirror should be as large as the fauces will conveniently accommo-

date in order to obtain a complete image. The patient should be directed to breathe quietly, to open the mouth without extraordinary effort, and care should be taken to avoid violent traction upon the tongue as well as dragging it downward upon the lower incisor teeth. It is rather more satisfactory for the examiner himself to hold the patient's tongue, except in the exercise of certain manipulations in which both hands are required, the movements of the head being thus under better control.

The introduction of the mirror in some individuals excites gagging and it is frequently impossible to obtain a satisfactory view without the aid of cocaine, or some form of local anesthesia, or careful preliminary training of the patient. Sometimes it is well to direct him to close his eyes during the examination. If gagging occurs, panting respirations may overcome the intolerance; or a four per cent. solution of cocaine may be sprayed into the fauces. It is well to avoid the pharyngeal wall, if possible, but the mirror should be introduced boldly, its back against the velum, which should be lifted firmly upward. Timidity in this procedure frequently is more disastrous than firmness. In introducing the mirror it is sometimes annoying to meet with considerable obstruction from upward curvation of the dorsum of the tongue which is overcome by directing the patient to phonate a long "ah." After the mirror has been placed in position, the interior of the larynx is brought into view by causing the patient to sing a falsetto "e," or to make the attempt, which is sufficient. In this way the movements of the cords and the arytenoids may be studied. In some instances the peculiar shape of the epiglottis is a source of difficulty. Occasionally it drops over the *rima glottidis* and cuts off the view of the cords. In other cases a lateral compression is noticed giving the conformation known as the "omega" shaped epiglottis. The impediment thus offered may be overcome, if an examination is imperative, by dragging the epiglottis upward and forward, after cocaineizing, by means of a sharp hook or tenaculum. The long tongue spatula of Bleyer or Escat is said to be particularly useful in examining children. The former has a curved end intended to be passed over the epiglottis, the latter has a bifurcated extremity, the prongs of which rest in the sinus pyriformis on either side (Fig. 118). The left index finger makes a very good tongue depressor and to children is less terrifying than an instrument. Traction

may be made by hooking it around the hyoid bone. The first laryngeal object seen in the mirror is the tip of the epiglottis. We then identify the ventricular bands and the prominences of the arytenoids and finally the white vocal bands. It should always be remembered that the laryngeal image is transposed antero-posteriorly, that is, the parts seen at the upper edge of the mirror while apparently most remote are really at the anterior wall of the larynx; those at the lower border are most distant and at the posterior



FIG. 118.—Escat's
Tongue Depressor.

commissure. The first view, especially in an untrained patient and without cocaine, gives us the most reliable picture of the laryngeal cavity, since prolonged examination excites muscular contraction and causes more or less congestion which is misleading. It is sometimes possible by tilting the mirror to get a view of the entire lateral wall and even a glimpse into the ventricles, as well as a considerable distance down the trachea, and in rare cases the bifurcation is visible. As a rule the anterior wall of the larynx is best seen in the ordinary method of making the examination. In order to more fully expose the posterior wall of the larynx and trachea, we sometimes adopt what is

known as the position of Killian, in which the patient is made to stand erect while the examiner is seated, the head of the subject being bent forward so that the eye of the observer looks upward at an angle. This is found to be useful in case of certain lesions at the posterior wall of the larynx. In subglottic laryngoscopy, as suggested by Mermod and others, a smaller mirror attached at a right angle to the laryngoscope is passed into or beyond the cavity of the larynx. The intralaryngeal mirror used by Gerber is oval in shape and its angle is governed by an ingenious mechanism which permits its introduction in a vertical position. The latter observer claims to have thus located a hemorrhage of doubtful origin in a varicosity on the under surface of a vocal band, while Max Senator detected in a similar situation and removed by cauterization a neoplasm which had robbed a well known tenor singer of his voice. The application of this method must be very limited. The misnamed instrument, the "autoscope"

of Kirstein, is intended to give a direct, or "orthoscopic," view of the larynx. Its essential part is a long spatula or concave piece designed to grasp the base of the tongue on either side of the median glossoepiglottic ligament. In the meantime the patient's head is extended forcibly in such a way as to bring the anteroposterior axis of the mouth in line with the vertical axis of the trachea. At the same time firm pressure upon the tongue drags the epiglottis forward and upward, and provided the patient is capable of submitting to this irksome position, in some cases a very good direct view of the larynx is obtained. It is necessary for the patient to be seated and the examiner to stand in front of him and a brilliant source of light should be provided. It seems to have been shown by Mosher that extreme extension may be avoided by rotating the head, or placing it in the "left lateral position," as it is called. A laryngeal spatula is passed over the epiglottis and by using the upper jaw as a fulcrum the larynx may be dragged forward and brought into view by the use of a surprisingly small amount of force. The original Kirstein's instrument had attached a small electric lamp, but the usual methods of reflection serve the purpose. This mode of examination is claimed to be especially applicable to children and for the removal of foreign bodies—but, with a little tact and patience, the ordinary methods usually succeed.

It is possible to gain additional information in some cases by other methods than inspection. External palpation, for instance, shows us whether the thyroid is, or is not, symmetrical, whether abnormal sensitiveness is present, and it is claimed to be of especial value in detecting laryngeal paralysis, which might not otherwise be recognized, in consequence of the absence of normal vibration on the affected side. A certain amount of corroborative evidence may be obtained by auscultation of the larynx; and it is a good plan for the examiner to educate his ear to the character of the voice, since in certain conditions peculiar qualities are more or less characteristic; for example, the rough, harsh voice of syphilitic laryngitis, the weak whispering voice of tuberculosis, and the metallic voice and especially the cough of recurrent paralysis are in some degree distinctive. In this connection the observations of Clark and Scripture on "the epileptic voice sign" are of interest. In addition we get valuable points, especially in cases of laryngeal neoplasm, by the use of the probe. We learn, for instance, some facts as regards the mobility

and the density of a tumor of the larynx. Above all one should never permit one's interest in the examination to prolong the process beyond the endurance of the patient, and if local hyperesthesia is so great as to prove insurmountable, it is certainly better to postpone attempts to get a view until the patient has been rendered manageable by the various methods of training elsewhere described.

GENERAL THERAPEUTICS.

The fact should never be forgotten that the larynx is only one part of the human machine, and that many laryngeal affections are aggravated and perpetuated as well as caused, by some systemic disturbance. One of the first indications in nearly every laryngeal lesion is to secure, as far as possible, absolute rest, not only as regards actual talking but by the avoidance of functional excitement as in the act of laughing, and in violent exercise. The use of tobacco and alcohol should be prohibited in acute and in many chronic conditions. The digestion must be looked into and a tendency to constipation corrected. Cough resulting from disease in the lungs or bronchi, or of a reflex character, must be investigated and its cause removed if possible. The habit of clearing the upper air passages by the act of hawking is a source of irritation, and is usually excited by some trouble in the nasal chambers. It is, therefore, important that in all cases of laryngeal disease the nose and pharynx should be carefully examined and be relieved of anomalies and deformities, although the immediate subjective symptoms the latter induce seem to be insignificant.

As to local therapeutics we may medicate the larynx by means of powders, inhalations, vapors or sprays. Fumigations are seldom resorted to in laryngeal difficulties and the use of lozenges and gargles in any form is, of course, futile. Gargling the larynx by the method of Guinier has been described, but it is by no means easy of accomplishment and cannot be considered very practical. Insufflations in laryngeal disease are limited to ulcerative processes. In some forms, as tuberculosis and carcinoma, certain powders seem to be beneficial in relieving pain and promoting asepsis. Medicated steam and vapors are most grateful in the simpler forms of acute inflammation.

For routine treatment the use of the spray is generally prac-

ticable and much more satisfaction is obtained by employing the straight tube, the patient being taught to practise deep inhalations at the moment of application. Used in this way little or no resistance or spasm of the larynx is likely to be excited; whereas, a blast of air directly upon the vocal bands, even if the solution it conveys be not very irritating, frequently produces distressing or alarming spasm. A similar objection applies to the introduction of applicators carrying medicaments into the larynx. The latter are reserved for inveterate cases of laryngitis in which the sensitiveness of the larynx is so obtunded that little or no contraction is excited by the presence of a foreign body. The sponge probang and brush of the early days of laryngology have been generally discarded. The special form of medication to be applied, whether antiseptic, astringent, sedative or stimulant, depends upon the particular lesion to be treated. These matters, as well as the question of instrumentation, will receive consideration under appropriate sections. We sometimes secure good results from external applications, either in the line of depletion, as with leeches, counter-irritation with iodine or the blister, or in certain acute and subacute conditions, Leiter's coil, or a water poultice. Experience with Bier's hyperemia is still too limited to warrant a confident opinion. Reports by certain observers, especially in the treatment of tuberculosis of the larynx, impress one as being rather extravagant.

CHAPTER XVIII.

DISEASES OF THE LARYNX. ANEMIA AND HYPEREMIA. LARYNGEAL HEMORRHAGE. ACUTE AND CHRONIC LARYNGITIS. CHORDITIS TUBEROSA, OR VOCAL NODULES. CHRONIC SUBGLOTTIC LARYNGITIS. ATROPHIC LARYNGITIS.

ANEMIA OF THE LARYNX.

Anemia of the larynx is observed in connection with general anemia, or as a "pretubercular" condition. In the chronic form of tuberculosis the laryngeal mucosa is often distinctly pale, even independently of structural changes. In chlorosis, in neurasthenic conditions, and especially in young girls about the age of puberty it is often seen. It merits especial attention as a forerunner of tuberculosis.

HYPEREMIA OF THE LARYNX.

Hyperemia of the larynx results from overuse of the voice, from the abuse of alcohol and tobacco, and also from certain occupations in which one is exposed to irritating atmosphere, smoke, dust, or chemical fumes. It is most marked where the tissues are lax, as on the aryepiglottic folds and ventricular bands; on the epiglottis and vocal bands it is less pronounced. It is also met with in the course of various exanthemata, either antecedent to or associated with skin lesions characteristic of these diseases. It is often a chronic, so to speak, normal condition in habitual voice-users, especially baritones and basses.

HEMORRHAGE OF THE LARYNX.

Hemorrhage of the larynx is a rare occurrence and seldom has any significance. It is extremely unusual to see a laryngeal hemorrhage in tuberculosis, although the sputa may be stained with blood, especially after violent attacks of coughing; whereas, in the ulcerative stage of carcinoma it is not infrequent. It may result from trauma-

tism, or from a foreign body, and has been met with in the course of syphilis as a consequence of destructive ulceration extending from the larynx to the base of the tongue and involving the lingual artery. It is seldom of sufficient moment to demand attention. A simple astringent spray usually controls it. Some writers recognize a so-called "hemorrhagic laryngitis," the main feature of which is the formation of scabs composed of coagulated blood adhering especially to the vocal bands, rather than a free bleeding. Gottstein regards it as a form of laryngitis "sicca," to be referred to later.

ACUTE LARYNGITIS.

Inflammation of the larynx may occur at any stage or in either sex. It is more often met with in those exposed to severe weather or sudden changes of temperature, and is rather more common in males in consequence of their particular occupations.

The causes of laryngitis are those affecting mucous membranes in general. Sudden changes in atmospheric conditions from hot to cold, mouth breathing due to nasal stenosis, damp clothing, especially in voice-users, functional activity of the larynx in bad air, or by a bad method, or to excess, are among the most frequent.

Predisposing causes are a depressed state of the system and gastrointestinal disturbances. Previous attacks of inflammation are thought to establish a proclivity and it is not unreasonable to suppose that the mucosa is rendered more vulnerable by preceding disease.

In the various exanthemata inflammation of the larynx is observed which differs in no respect from simple catarrhal laryngitis except that, in some varieties, are developed lesions similar to those occurring upon the skin. In chicken-pox, for example, vesicles are seen upon the epiglottis which break and resemble aphthæ. In measles, diffuse patches or maculæ frequently occur. In scarlatina the laryngitis is occasionally complicated by the formation of a pseudo-membrane and an unusual degree of edema is present especially when renal complications arise. In the laryngitis of typhoid fever a decubitus ulcer may form, or ulceration involving the lymphoid tissue resembling that of Peyer's patches is not infrequently noticed. The laryngitis of erysipelas is rare and exceptionally dangerous when the phlegmonous type is assumed.

The pathology of acute laryngitis resembles that of inflammation

of other parts of the air tract except that the catarrhal product is deficient in mucus owing to the relative scarcity of glandular tissue. In the first stage, as elsewhere, there is active hyperemia with dryness, followed by tumefaction of the membrane and serous exudation which finally becomes tenacious and turbid from the admixture of epithelial cells and leucocytes. In the majority of cases resolution takes place and the parts resume their normal appearance without change. In other cases the condition lapses into one of chronic inflammation. In some instances erosions of the mucosa take place but no true ulcerative process is observed.

The first symptoms noticed are slight hoarseness, a tendency to cough, and subjective sensations of dryness and tickling, sometimes with a feeling of constriction. The use of the voice is uncomfortable and even painful in aggravated cases, or it is completely lost early in the attack. In children the swelling of the mucous membrane produces more impediment to respiration in consequence of the relatively smaller dimensions of the larynx in the young but it seldom becomes serious unless complicated by edema. There may be slight pyrexia especially in children or nervous individuals; and in sleep the breathing is somewhat noisy or strident. In the mirror the mucous membrane is seen to be uniformly congested, or injected vessels are identified at various regions. Occasionally when the coughing is very violent rupture of small vessels takes place and the sputum is tinged with blood. The vocal bands lose their pearly hue or are concealed by swelling of the ventricular bands.

The *treatment* should be more active in the case of children than in adults, although in the latter a laryngitis should never be neglected, owing to its weakening effect upon the membranes and the possibility of a chronic condition supervening. It should begin with a calomel purge, fractional doses, one-tenth of a grain, being given every half hour until characteristic effects are produced. The patient should be kept in a warm even temperature, given hot drinks to promote the action of the skin and forbidden to use his voice. If cough is a prominent symptom it should be controlled by the use of an opiate, preferably codeine or heroin, and by means of steam inhalations. The compound tincture of benzoin in water at the boiling point, one drachm to the pint, makes a soothing medicated vapor useful in these cases. It is said that dilute nitric acid in doses

of from ten to fifteen drops every half hour for four or five doses, and then at longer intervals for a few hours will enable a singer or a public speaker to use his voice provided the remedy be resorted to at an early stage. The relief from this measure is only temporary and it is, by no means, to be recommended except in cases of emergency. Menthol inhalations, or vapors of menthol, applied by means of the atomizer or nebulizer, often give relief, the strength of menthol being about five grains to the ounce of fluid albolene. It is well in using the spray in these acute conditions to employ the straight rather than the down tube, the patient being instructed to inhale at the moment the spray is formed. It is unwise to use too much energy in local treatment. All applications should be emollient and protective.

External applications of water poultice, flannel wrung out in hot water, applied next to the skin and covered with a larger piece of oiled silk, known in Germany as the Priessnitz compress, give some degree of relief. If the case is seen in the early stage it is sometimes possible to abort it by external counter-irritation, depletion by means of leeches, or the application of Leiter's ice-water coil. By far the most important indication, in cases of acute laryngitis, is to enforce absolute rest. The patient should be isolated so far as possible, kept in an equable temperature and not allowed to use his voice in any way. In the event of the development of edema to a threatening degree it is necessary to resort to scarification or puncture of the swollen tissues with Tobold's concealed lancet. If relief is not obtained in this way the question of intubation or tracheotomy is before us. The former, in several cases recorded, has given most excellent results, but if the edema is situated high in the larynx it may be ineffectual on account of the occlusion of the upper orifice of the tube by the overhanging tumefaction. Or the serous infiltration may extend beyond the lower end of the tube. In still other cases it may constitute what has been termed a "solid edema," upon which scarification makes no impression. In such case relief must be obtained by passage of a catheter through the stenosed air tract, as proposed by McEwen, or by a tracheotomy. Usually edema affects the vestibule of the larynx where it is within reach, but cases have been reported by Semon and by Risch in which the process was limited to the vocal bands. An extraordinary obstacle was met with by Casselberry in attempting an intubation for

edema of the glottis. The jaws were so firmly fixed by spasm of the masseter muscles as to render opening of the mouth impossible. It is advisable to select a tube rather under the size indicated by the age of the patient and in adults it is passed under the guidance of a laryngeal mirror. A combination of scarification with intubation may be efficacious when the tube is found too short to compress all of the swollen area. Efforts to introduce the tube may lacerate the tissues and release the effused serum. All the evidence seems to show that a trial should be made of these measures before resort is had to the more formidable external operation. Fortunately, owing to the fact that simple catarrhal inflammation does not invade the submucous areolar tissue to any extent, *edema* as a complication of an acute laryngitis is very exceptional. By propagation from the pharynx, as pointed out by Sestier, it is more common, and it is sometimes consecutive to disease involving the perichondrium or the cartilages of the larynx. Secondary to syphilitic or tuberculous infiltration it is more apt to be a chronic than an acute edema and seldom demands attention. Fauvel refers to it as being possibly the first symptom of renal disease, yet Mackenzie affirms that he once examined 200 cases of Bright's disease without discovering a single instance of edema of the larynx. Local depletion by means of leeches applied over the larynx externally and spraying the fauces and larynx at intervals with a solution of suprarenal extract may relieve the turgid structures. In this connection the experience of S. Solis-Cohen in a case of asthma in which acute edema of the palate, pharynx and epiglottis followed a free application of the suprarenal-chloretone solution is of interest. A disease of which the laryngeal edema is symptomatic must of course receive appropriate treatment. Primary "edematous laryngitis" is an exceedingly rare phenomenon. Edema of the glottis as a symptom or sequel of disease is not infrequently observed and occasionally reaches proportions to excite alarm or involve danger. In the convalescent stage of acute laryngitis it may be necessary to brace up the relaxed membranes by means of mild astringent applications; the one preferred at the present time is a 10 or 20 grain watery solution of alumnol. Preparations of iron, chloride of zinc and nitrate of silver are more distasteful and offer no superiority. Within recent years many new silver combinations have been offered. Among the most promising is silver vitelline,

or argyrol, a proteid containing 30 per cent. of silver. It is very soluble, is absolutely free from irritating or caustic properties, and possesses great penetrating power owing to the fact that it does not precipitate albumen or sodium chloride. Hence we may expect the most brilliant results in derangements supposed to be dependent upon invasion of the submucous structures by bacterial organisms.

CHRONIC LARYNGITIS.

Chronic laryngitis is, as a rule, a sequel of the acute form, or inflammation may extend to the larynx from the pharyngeal cavity. By far the larger number of cases of chronic laryngitis owe their origin primarily to a nasal stenosis or disease in the nasal chambers which causes mouth-breathing or some change in the condition of the air supplied to the lungs as regards purity, temperature, or moisture. The abuse of alcohol and tobacco, exposure to irritating vapors in certain occupations, excessive use of the voice, as in open-air speakers and street hawkers, are frequent causes. In addition derangements of the fauces, such as hypertrophied tonsils or an elongated uvula, are predisposing causes. The influence of certain diatheses, as gout and rheumatism, should not be overlooked. Sooner or later in the condition of chronic laryngitis, a proliferation of connective tissue cells takes place resulting in thickening of the tissues, this thickening not only involving the epithelial layer but the submucosa as well. Structural changes may invade the muscular tissues. Involvement of the framework of the larynx is met with only in the existence of constitutional trouble, such as syphilis, tuberculosis, or malignant disease. Frequently, the pathological changes are circumscribed and affect a very limited area of the mucous membrane, constituting what is known as "singers' nodes" or *chorditis tuberosa* of Türck. These developments are most frequent at the junction of the anterior with the middle third of the vocal bands. Sometimes the node is on the margin and again on the upper surface of the band and apparently incorporated with it. In the former case if the lesion is unilateral a depression may be seen at a corresponding point on the opposite cord. In many cases the lesion is bilateral and symmetrical. The cord as a whole is slightly if at all altered in appearance, or there is a moderate amount of hyperemia, especially in the immediate neighborhood of the node. A similar circumscribed increase in connective tissue elements is

sometimes noticed at the posterior commissure, or near the vocal processes, where the condition has been termed by Virchow *pachydermia laryngis*.

The *symptoms* of chronic laryngitis are unmistakable. The voice is partially or completely lost. It is apt to break unexpectedly and, in all cases, a condition of dysphonia exists and the patient is himself conscious of being compelled to make an extra effort to produce a tone. After a night's rest there is always an accumulation of viscid tenacious secretion, the expulsion of which is accomplished by more or less violent cough and, at all times, the patient is disposed to cough especially in attempting to speak or after the use of the voice. Sometimes the voice, even when exceptionally hoarse, clears up slightly after a few minutes' use. Patients frequently complain of a sensation of constriction or foreign body in the region of the larynx. Upon inspection with the mirror we find a congested mucous membrane with blood-vessels well defined upon the epiglottis or in the larynx itself. The tissues at the base of the cords are frequently more hyperemic than the margins of the cords themselves; or the margins of the vocal bands are irregularly eroded. As a rule, the most marked changes are seen at the posterior wall of the larynx. Thickening of tissue occurring at that situation may interfere with approximation of the arytenoid cartilages and the aphonia is due in part to the obstacle thus offered. Interference with the action of the intrinsic muscles of the larynx is mechanical and not a true paresis.

The *prognosis* depends upon the duration and extent of the inflammatory process; other things being equal, the more prolonged the condition the less likelihood of complete restoration of the voice. The larynx, once the seat of an aggravated degree of chronic inflammation, can never produce a tone of original quality and clearness even though all inflammatory symptoms have subsided.

The *treatment* usually consists, in the first instance, of a reform of habits which tend to irritate the larynx, and of possible constitutional states which induce a tendency to laryngeal hyperemia. Attention should be paid to diet and to correction of gastrointestinal derangement. Good hygiene should be secured and, in many cases, tonics are indicated.

Locally, stimulating inhalations of oil of pine, or nascent muriate of ammonia are useful, after the surface has been cleansed, if

necessary, with alkaline solutions. In all cases attention should be paid to the condition of the upper air tract and, before we can hope to get satisfactory results in chronic laryngeal inflammation, all nasal obstructions and pharyngeal abnormalities should be removed.

In chronic cases some benefit is derived from astringent sprays, as applications of chloride of zinc, 10 to 30 grains to the ounce in watery solution, or nitrate of silver, 30 grains to the ounce and upward. Silver solution should always be used in the larynx with great caution unless we know that our patient is tolerant of intralaryngeal applications. It not infrequently happens that violent and alarming spasm of the larynx is excited by the introduction of even the simplest medicament. It quickly subsides if the patient is able to take shallow rapid respirations instead of trying to breathe deeply. The use of brushes and swabs in the larynx is much inferior to that of the spray. Any intelligent person can be taught to inhale gently during the process and thus carry the spray into the laryngeal cavity. This method is effective and more agreeable than the introduction of a cotton wound applicator. The latter finds its place in connection with the use of caustic or concentrated solutions, the diffusion of which is to be avoided. Tobacco and alcohol should be interdicted and the patient should be warned to exercise great caution in the use of the voice. In some cases removal to an equable climate must be insisted upon. Of late, much attention has been paid to the effect of suitable vocal exercise upon hyperplastic changes of the mucous membrane in chronic laryngitis and especially in the thickening known as "singers' nodes." A careful study of these cases will sometimes teach us whether this mode of handling them is likely to be effective. In cases of long standing, when the nodes are very dense and extensive, we can hope to accomplish but little. In more recent cases it is possible that suitable exercise of the voice may be of advantage, the theory being that dispersion of the infiltration or hyperplasia is effected by a so-called *vocal massage* of the laryngeal structures. The term used in this sense is certainly a misnomer. The spontaneous disappearance of the nodes under absolute rest is sometimes observed and the question arises whether the moderate use of the voice in such vocal exercises as are recommended is not practically a modified rest.

The observations of Garel and Bernand fail to confirm the opinion of Fränkel that the changes resulting in the formation of

these nodes begin in the glandular structures. In some cases they proved to be small fibromyxomata; in others the changes were in the mucous membrane and chiefly vascular. In their experience the nodes sometimes disappear spontaneously, the galvanocautery has often been employed with success, but ablation with cutting forceps is much to be preferred. From examinations of the tissues composing the nodes made by Rice, Kanthack, Chiari and other investigators it seems to be proven that they are not of glandular origin but consist mainly of connective tissue and epithelial elements. Attention has been drawn by F. I. Knight to the confusion existing between this condition and a diffuse granular inflammation involving the whole cord, or *trachoma* of the vocal cord. As a matter of fact there may be few or none of the usual local signs of inflammation. The term *chorditis* is therefore open to criticism; moreover, it is more appropriate to refer to these nodes as "vocal" rather than "singers' " nodules, since they occur not infrequently in those who do not sing. There seems to be no evidence to sustain the suspicion of a relationship between vocal nodules and a tuberculous diathesis. In reviewing the anatomy of the larynx reference was made to the curious distribution of the thyroarytenoid muscle to the margin of the vocal band. The interesting question suggests itself whether persistent and oft-repeated tugging or strain upon certain fibers may not induce a hyperemia or even a minute hemorrhage to develop later a vocal nodule.

It seems to be desirable to distinguish between "trachoma" of the vocal cord, a condition of diffuse inflammation resembling a granular or follicular pharyngitis and involving the whole extent of the band; "pachydermia laryngis," which is a hyperplastic overgrowth at the posterior commissure and in the neighborhood of the vocal processes; and, finally, "chorditis tuberosa," or vocal nodules, isolated nodular masses usually seated at the junction of the anterior and middle thirds of a vocal band, commonly bilateral, often only on one side. However closely allied these conditions may be pathologically, their respective clinical pictures are sufficiently in contrast to award them separate titles. They equally impede phonation and are equally resistant to treatment, which should be invariably preceded by careful elimination of morbid conditions in the superior air-tract.

The surgical treatment of these thickened tissues, as a rule should

be avoided since there is danger that the intralaryngeal manipulations, essential to the removal of a broad-based sessile overgrowth, will do more damage than the hyperplasia itself. If the growth is pedunculated, or on the margin of the cord and in a well-trained subject it is possible to excise the little tumor with a small cutting forceps, or to destroy it with a fine electric cautery point. Capart divides the treatment of "singers' nodes" into hygienic, medical and operative. Although several instances of spontaneous disappearance have been recorded, he believes that even prolonged rest of the larynx has no beneficial effect except upon an associated laryngitis. He condemns local treatment by sprays and insufflations of astringents and antiseptics, and especially cauterization with nitrate of silver and chromic acid as being either ineffective or positively dangerous, in consequence of a tendency for these agents to spread and cause violent reaction. In operative treatment are included ablation and destruction with the galvanocautery. For the former a light and very delicate forceps is advised. The galvanocautery is reserved for nodes too small to be grasped with forceps.

At best the management of these cases is very discouraging. In most cases the forceps is not available, the use of the cautery demands the utmost skill and delicacy and is to be thought of only in trained and tolerant subjects, and finally the enforcement of absolute rest, while most essential, is almost impossible.

CHRONIC SUBGLOTTIC LARYNGITIS.

An inflammatory process sometimes seems to expend itself on the under surface of the vocal bands and the adjacent wall of the larynx. It often leads to considerable thickening and in the laryngeal mirror gives the image referred to by Mackenzie as that of "a second vocal cord." The affected region is usually redder than normal and looks dense and firm. At first it is uniformly smooth, but in old cases may become somewhat irregular and even eroded. It has been described by Gerhardt as a *chorditis vocalis inferior*, but the process is by no means limited to the vocal bands, a considerable area beyond them being involved. It is not common in this country. Some observers trace it to a constitutional diathesis, scrofula, syphilis, or tuberculosis, while others regard it as related to rhinoscleroma. The symmetry, color and density of the swellings, obvious to the eye

as well as on examination with a probe, differentiate this disease from edema and from that rare variety of myxomatous degeneration to be described elsewhere. It has been mistaken for eversion of the ventricles, a lesion the occurrence of which is denied by many authorities. Its chief title to importance rests on the fact that it may embarrass respiration to a degree necessitating an intubation or a tracheotomy. Systematic dilatation may be required or the hypertrophied tissues may be reduced by excision or by applications of the galvanocautery. In some cases the movements of the vocal bands are decidedly interfered with by thickening or by infiltration of the muscles by inflammatory products and the voice suffers proportionately. In others the vocal bands move with normal freedom and may quite conceal the hypoglottic swelling during phonation. The probable relationship of this affection to a constitutional diathesis enforces the importance of internal medication. Iron preparations, especially the iodide of iron, are said to be useful. Bosworth warns against the administration of iodide of potash, lest an edema add to the volume of the obstructing hyperplasia. Yet the cautious use of the latter drug seems to be indicated when there exists a suspicion of syphilitic taint. Local applications, other than those directed toward reducing hyperemia or actual removal of the infiltration are worse than useless.

ATROPHIC LARYNGITIS.

Pathological changes similar to those occurring in the nose and pharynx and resulting in atrophy takes place in the larynx, when there is presented the condition known as atrophic laryngitis, or *laryngitis sicca*. Some confusion has arisen from the use of different terms to indicate what are probably identical diseases, the blennorrhoea of Stoerk, the *ozena laryngis* of Baginski, and so on, according to the prominence of a given symptom. As a matter of fact the disease is extremely rare and is a sequel of an analogous condition in the air tract above, which latter is actually the more important. The chief characteristic of atrophic laryngitis is a perversion of secretion, whereby the mucus having lost a proportion of its watery elements tends to form crusts or scales which adhere firmly to the membrane. At times these scabs cling so closely that bleeding takes place when they are forcibly dislodged. They consist of blood, mucus and epithelial debris and have a very fetid odor, which they

impart to the breath. The mucous membrane is eroded and if the vocal bands are affected their margins are notched and irregular. The crusts may be seen at almost any part of the larynx or extending down into the trachea. In a case described by B. Tauber the larynx and upper part of the trachea were lined completely by a blackish cast of incrustrated secretion which had to be removed daily with forceps. The voice is absent until the desiccated secretion is expelled, and the crusts may be so thick as to cause dyspnea. Their presence is provocative of violent and often painful paroxysms of coughing. In some cases there is more or less concomitant acute or subacute catarrhal inflammation, when the membranes are swollen and red, while Gottstein describes a chronic form in which the mucosa is dirty gray in color. This affection seems to be peculiar to adults and is said to be more common in women. It is not infrequently seen in those who use alcohol to excess and in syphilitics. Massei and others maintain that atrophy in the larynx is a direct extension of a similar state in the pharynx, while Bosworth lays great stress on the theory that catarrhal processes are limited by anatomical boundaries and do not extend by continuity of tissue. In any case it is a clinical fact that the morbid process in the larynx is secondary to some abnormality, atrophic or other, in the nose or pharynx which compels mouth breathing or interferes with suitable purification of inspired air. The presence of certain bacteria in the secretions, especially the *bacillus fetidus*, is looked upon by some as an etiological factor, but by most observers as a coincidence or consequence.

The prognosis and treatment resemble those applying to atrophy in other situations. If the process is not too far advanced the normal function of the affected region may be restored by preliminary cleansing of the surface followed by soothing or slightly stimulating applications in an oily vehicle. The crusts may be softened with an alkaline spray, or may require detachment mechanically. Inhalation of benzoinated steam is grateful and helps to loosen the secretions. Kyle highly recommends embrocations of petroleum externally. Internal medication is needed if the general health is poor or in the existence of a constitutional dyscrasia. The prolonged use of large doses of iodide of potash rather predisposes to atrophy, yet it is an indispensable drug in syphilis. At best response to treatment is slow, and the nose and pharynx must first be free from disease.

CHAPTER XIX.

BENIGN NEOPLASMS OF THE LARYNX.

A benign tumor of the larynx may be defined as one which shows no tendency to general dissemination and does not recur after thorough removal. The latter part of the definition exempts one variety of benign growth, namely, papillomata, which do show a disposition to return after extirpation. However, the presumption is that even with these recurrence is due to failure of complete removal, although many cases are on record in which apparently thorough resection followed by cauterization through a thyrotomy wound has proved ineffectual.

In the etiology of benign tumors in general any condition or circumstance which promotes hyperemia or catarrhal inflammation is a predisposing cause. Voice strain, local irritants, and a tendency on the part of certain individuals to neoplastic formations, a "verrucous diathesis," are included among these causes. How far overuse or misuse of the voice should be considered a factor is more or less of an open question in view of Morell Mackenzie's famous case of papilloma occurring in a deaf mute. The majority of cases of laryngeal neoplasm have been met with in the adult and in the male sex. There are on record several congenital cases.

The *symptoms* include alteration of voice varying with the situation of the tumor, cough, more or less interference with breathing, especially in children, spasm of the larynx, moderate concomitant inflammation in some instances, hyperesthesia amounting in exceptional cases to actual pain, and in some varieties hemorrhage. Among rare phenomena associated with certain benign neoplasms noted by Fauvel may be mentioned salivation and perversion of the sense of taste. Impairment of voice varies from slight hoarseness to complete aphonia, and is more pronounced when the vocal bands are involved, or when the growth is sessile and small than when pedunculated even though voluminous (Czermak). The respiratory disturbance is influenced more by the size of the tumor, although

paroxysmal dyspnea may occur under excitement, on exertion, or when the glottic aperture is still further narrowed by sudden swelling from catarrhal inflammation. A change in position of a pedunculated growth may have a similar effect. When inspiration is more impeded than expiration, the growth is probably *above* the vocal bands (Lewin). An extraordinary subjective symptom, or more properly premonition of laryngeal neoplasm, was recently detailed to me by a young man with papilloma. He is an amateur short distance runner, and after a very keen competition he once noticed a feeling of intense *heat* in the region of the larynx followed by partial loss of voice, the former lasting for upward of an hour and the latter continuing through the following day. This was repeated after several subsequent contests until the partial aphonia became permanent and he was led to seek relief.

The tendency to malignant degeneration of benign growths in the larynx has been the subject of much controversy. The testimony is for the most part in refutation, Felix Semon finding ground from extensive statistics he has collected to maintain that it is less marked when operation has been done than when the tumors have been let alone. It must be admitted that new growths may become modified from their original type. For instance, a fibroma may grow more vascular and finally appear as a genuine angioma, or may undergo fatty degeneration. A case of transformation into myxoma has been reported by Masucci. In a recent address Crile includes papilloma of the larynx among benign growths predisposing to cancer, and the assertion is made by E. A. Babler that malignant changes in warts and moles are quite frequent. If this be true of skin lesions it may also apply to those of mucous membranes and statements like the foregoing are likely to reopen the question for further discussion. The verdict has been hitherto that malignant degeneration of an innocent laryngeal neoplasm as a result of irritation or traumatism is not proven.

The *prognosis* is good, unless the growth is excessive, or, as in the case of some papillomata, shows a propensity to recur, in which case the voice is liable to be permanently impaired. Several cases of spontaneous detachment and expulsion are on record as in one of four congenital cases reported by H. A. Johnson, in which a papilloma was expelled during a paroxysm of whooping cough. As a rule, the development of the growth is so gradual that ample time is

given for a tracheotomy before indications of dangerous stenosis are presented.

In order of frequency benign tumors of the larynx may be enumerated as follows: papilloma, fibroma, cystoma, myxoma, angioma, enchondroma, lipoma, and adenoma. The most frequent by far is the first mentioned, *papilloma*. Papillomata commence in the papillæ of the mucosa, involve the epithelial cells and form wart-like growths, called by Virchow *pachydermia verrucosa*. They are usually situated on the vocal bands and at the anterior part of the larynx (Fig. 119). They rarely occur elsewhere and almost never at the

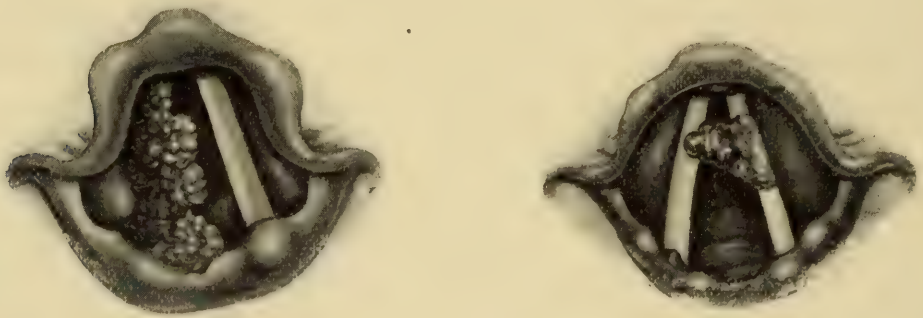


FIG. 119.—Papilloma of Larynx. (Schnitzler.)

posterior commissure. A form of excrescence resembling papilloma occurring in tuberculous laryngitis in the interarytenoid space is not entitled to be thus classified. They are frequently more or less pedunculated and they usually develop rapidly, especially in children, and, in most cases, occupy the supraglottic region. In many cases fungous or cauliflower expansion of the mass of the tumor is very apparent.

Fibroma is a neoplasm of adult life. It is usually sessile and single, situated on one or the other vocal band, varying in size from that of a millet seed to a hazelnut or, in rare cases, almost filling the laryngeal cavity (Fig. 120). Usually it is round, symmetrical and redder than the band to which it is attached. A single case of fibroma of the larynx has come under my observation, in which I removed a growth the size of a small pea from a vocal band with Mackenzie's forceps. Growths in this class are spoken of as soft fibromata or fibrocellular, when their structure is made up in large part of cellular elements. In exceptional cases the tumor has been known to reach extraordinary dimensions, as in the

instance reported by Chappell. A fibroma springing from the left aryepiglottic fold projected into and nearly filled the pharynx where it had formed several adhesions. It was successfully removed by subhyoid pharyngotomy, after preliminary tracheotomy, and was found to weigh 20 grams and measure 4 1/2 inches in circumference.



FIG. 120.—Fibroma of Larynx on Phonation (a) and During Respiration (b).

Cystomata have been met with in adult life as late as the sixty-fourth year as well as in young children. They occur in the form of retention cysts of the muciparous glands at almost any situation, the vocal cords included (Fig. 121). The epiglottis seems to be the favorite site (Fig. 122). In a case of cyst of the epiglottis under my care several years ago a tumor the size of a hickory nut was attached by a long pedicle to the left margin of the epiglottis. That organ was dragged downward by the tumor so as to conceal the

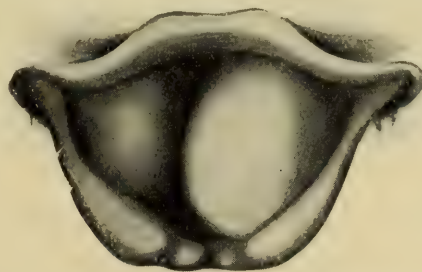


FIG. 121.—Cyst of Larynx. (Ingals.)

interior of the larynx. The tumor itself was not to be seen until forced into view by the act of retching. It was easily removed with the cold-wire snare. In some cases in which the tumor was small and sessile simple incision has been sufficient to effect a cure, as in a case described by Payson Clark, in which the tumor, attached to a vocal band, could not be seized with forceps. It was therefore in-

cised with a concealed lancet. A little milky fluid escaped, and the cyst walls collapsed and shrank away. Four varieties are enumerated by Emil Glas: 1. Retention cysts due to clogging of the duct of a lymphatic gland. 2. Congenital cysts resulting from a fault in development. 3. Traumatic cysts analogous to those cystic tumors of the iris described by Fuchs as following a perforating wound. 4. Lymphatic cysts, the rarest variety in which are included those due to degeneration of polypoid growths as well as those caused by hemorrhagic extravasation. The last mentioned is perhaps the more frequent mode of formation.



FIG. 122.—Cyst of Epiglottis.

These neoplasms are neither sensitive nor vascular. It is well enough to cocainize the parts before removal is attempted, but any special precautions against hemorrhage are superfluous. The diagnosis is clear. They are usually pedunculated and elastic and are more or less translucent, provided their contents are fluid and serous, but not if they contain gelatinous, colloid, or bloody material as in certain rare cases (Lefferts). The size of these growths varies. They may become so large as to necessitate a tracheotomy or even as in one case a pharyngotomy. They may occur at any age. One about the size of a hempseed has been found post mortem in a child fourteen days old (Abercrombie), and one the size of a hazelnut is reported to have caused the death of an infant thirty-seven hours after birth (Edis).

Myxoma may occur in two forms, either as a pedunculated tumor

generally situated upon a vocal band, or in the form of a sessile diffuse mass, a sort of myxomatous degeneration.

A case of diffuse subglottic myxoma came under my observation several years since in the person of a woman forty-eight years of age, who had been hoarse and annoyed by wheezing respiration for a year or more (Fig. 123). She had some cough and was supposed to have asthma. No pulmonary lesion could be detected, but with the laryngoscope a mass of finely lobulated tissue could be seen extending from the under surface of the vocal bands down into the trachea and encroaching upon the air-tube. Portions of this mass were removed with Mackenzie's cutting forceps until it became evident that the lower limit of the growth



FIG. 123.—Subglottic Myxoma. (*Author's specimen.*)

could not be reached through the mouth. So much relief was given by partial removal that treatment was intermitted for more than a year when the patient began to have a good deal of dyspnea and stridulous breathing. An external operation was then done under cocaine anesthesia, the cricoid and three upper rings of the trachea being divided and a large quantity of soft pulpy material was removed with the curette and cutting forceps. The tracheal tube was worn for three days and at the end of the third week the tracheal opening had healed and the patient was discharged from the hospital. Under the microscope the growth was seen to be made up chiefly of myxomatous tissue.

Angiomata, or vascular tumors, are very uncommon. They are usually single and incorporated with a vocal band, and frequently contain a large proportion of fibrous tissue. They have generally been observed in adults and with one exception only on one side of the larynx. They vary in color at different times, on some occasions being blanched, at other times vivid red in hue. In an interesting case reported by A. J. Brady a globular angioma, the size of a cherry, was removed from below the vocal bands at the anterior commissure by means of a Heryng's curette. The patient was a boy, age not given, who had cough with hoarseness and bloody expectoration. Repeated attempts to remove the tumor with forceps under cocaine failed. No view could be obtained by Kirstein's mode of examination. Finally under moderate chloroform anesthesia, the laryngeal reflex not being abolished, the mass was removed with the curette in two sittings ten days apart, with complete relief of symptoms. Unfortunately the diagnosis does not seem to have been confirmed by the microscope and the loss of blood at the operation was surprisingly scanty. Most operators would consider it injudicious to undertake the removal of an angioma with cutting instruments, and an approach to a tumor of this kind seated below the vocal bands by an external operation might be deemed preferable.

Enchondroma, or more properly *ecchondrosis*, the latter being the appropriate term for homologous tumors composed of cartilage, may spring from any of the cartilages of the larynx, is always of slow growth and occurs in adult life. It is usually made up of pure hyaline cartilage, with a possible admixture of fibrous and even bony tissue. An ecchondrosis apparently projecting toward the lumen of the larynx from the base of the right superior cornu of the thyroid was once removed by Asch with a modified Stoerk guillotine. A curious feature of the case was that the patient, an amateur vocalist, subsequently gained two notes in his upper register.

According to Gerhardt there were on record in 1896 only ten cases of *lipoma* of the larynx, five of which were removed during life. Several cases have since been added to the number. Kyle states that the neoplasm shows a disposition to recur suggestive of a possible tendency toward malignant degeneration. Bosworth gives the details of four cases of lipoma of the larynx as follows. One was reported by Holt in a man of eighty years. It was pedunculated, upon the rim of the glottis, and had given rise to symptoms for 12

years. It was drawn into the larynx and caused fatal asphyxia. In a second case, reported by Jones, the lipoma, two inches in diameter, was removed through the mouth. In a third case, reported by Macleod, a pharyngotomy for a tumor as large as an orange was followed by fatal hemorrhage. Bruns records the case of a woman, twenty-five years old, who had a congenital lipoma removed piecemeal with the galvanocautery in fifteen sittings.

The existence of *adenoma*, which is included in the list, is denied by many authorities. F. Massei has reported two cases, but his, as well as several described by other observers, are far from being well



FIG. 124.—Mackenzie's Laryngeal Cutting Forceps.

authenticated. To the foregoing may be added *lymphomata* and *accessory thyroid tumors*, each of them so rare as to be considered clinical curiosities.

The *treatment* of these cases of benign tumor must be guided by the character of the growth and its situation. Unless very extensive or excessively vascular the best results are obtained by endolaryngeal operation with forceps, except in cases of relapsing papillomata. Many operators give preference to instruments like the snap guillotine of Mathieu, or Dundas Grant's safety forceps, but the instrument adapted to the majority of cases is that designed by Morell Mackenzie, a double curette forceps, one pattern intended to cut anteroposteriorly, the other transversely (Fig. 124). One of the most convenient forceps, where for any reason Mackenzie's is

found to be difficult of manipulation, is known as the Schroetter-Türk canula forceps (Fig. 125). Some cases can be handled by the

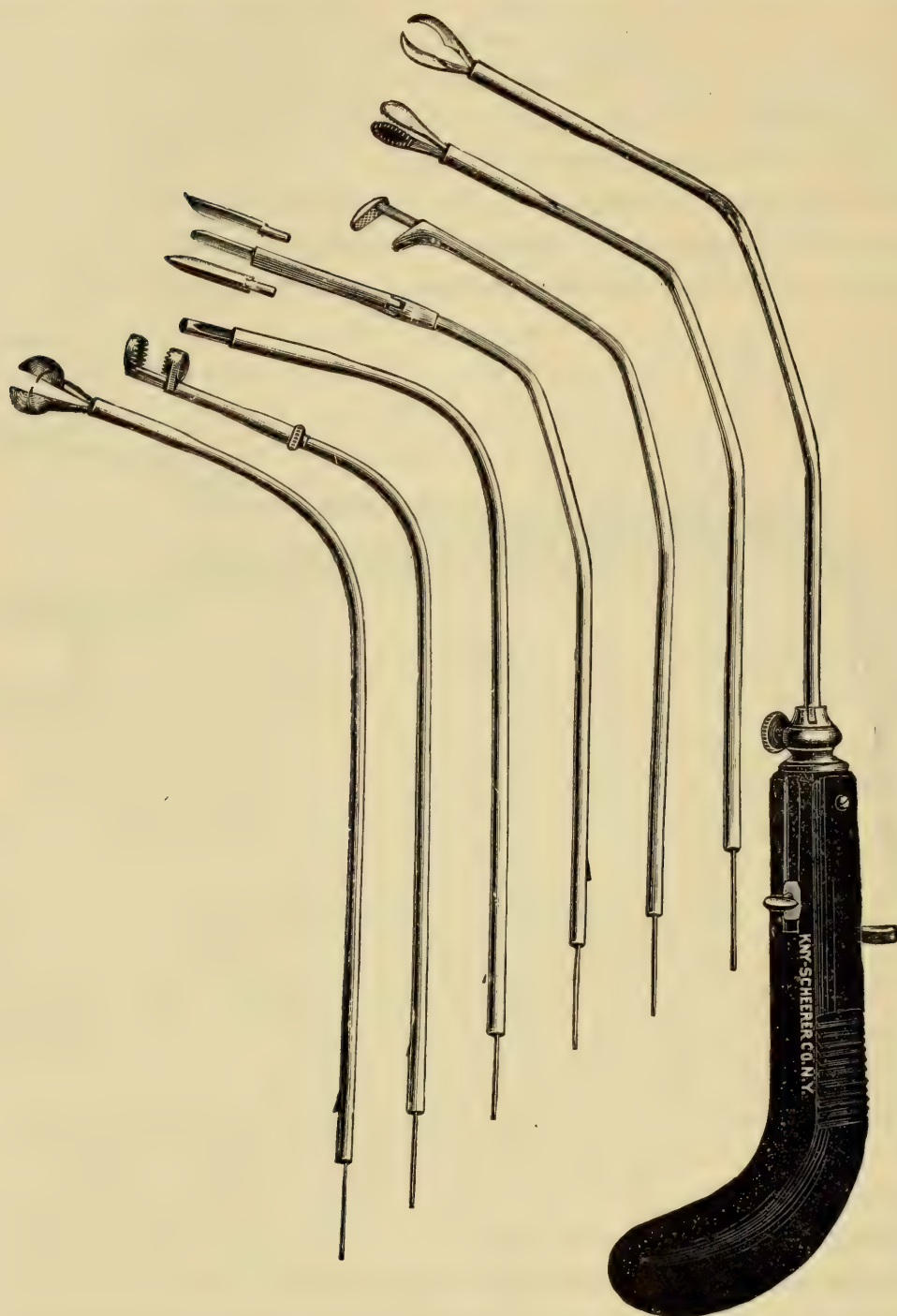


FIG. 125.—Schroetter-Türk Canula Forceps.

cold-wire snare. A very crude method, suggested years ago by Voltolini, consists in passing a sponge-probang below the cords and then quickly withdrawing it in the hope that the growth may

be caught in its meshes and torn away. It cannot be considered a highly surgical procedure. Chemical caustics have been used from time to time but the difficulty here as elsewhere is to restrict their action to the neoplasm. In at least one case of multiple papillomata in which removal had been attempted with the forceps and the growth had shown a disposition to prompt recurrence, an intubation tube coated with chromic acid was passed and allowed to remain *in situ* for a number of hours; on removal it brought with it masses of sloughing neoplasm. Incidentally may be mentioned an ingenious application of intubation attributed to Lichtwitz. A tube made with a fenestra permits the growth to protrude into its lumen, where it may be snipped off without risk to the wall of the larynx. Bosworth advocates the use of chromic acid fused on a probe, or conveyed on a hooded porte-caustique, especially to destroy small fragments left by the main operation. Morell Mackenzie, who at one time recommended "London paste," finally abandoned it because it excited spasm of the glottis and inflammation of adjacent mucous membrane. It must be admitted that the use of agents of this kind in effective strength is attended by danger.

The galvanocautery is more precise and manageable and is decidedly more satisfactory in its results. The use of the galvanocautery below the epiglottis is objected to by Lennox Browne and other observers, but cases in my own experience convince me that it is a most valuable agent here as elsewhere under proper precautions. No manipulation of any kind should be undertaken without preliminary training of the patient. Unless the larynx is under good control there is great danger that the constrictors may bring in contact with the hot electrode or into the grasp of the forceps portions of the laryngeal structure which should not be damaged. Since the introduction of cocaine endolaryngeal surgery has been greatly facilitated, and a good degree of tolerance is established by spraying a 10 per cent. solution of cocaine into the larynx and pharynx. In using the laryngeal forceps of Mackenzie the following method of technic is adopted: The parts are first well sprayed with cocaine, a large laryngeal mirror held in the left hand of the operator is introduced and the forceps, having been warmed, is passed over the epiglottis into the larynx with blades closed. If resistance is excited the patient is directed to take gasping respirations, or to phonate the falsetto "e" and thus the larynx is brought to

a higher level. At the same time the spasm relaxes and the neoplasm becomes visible. Advantage of this momentary glimpse should be taken to open the blades and seize the growth. It sometimes happens in cases of multiple papilloma for example, that it is only necessary to open and close the blades without actually seeing the growth at the moment, when more or less of the neoplastic tissue will be included in their grasp. In the use of Mackenzie's forceps there is but little danger of seizing sound tissues provided the instrument be kept in the middle line. It is not well to repeat manipulations more than two or three times at a sitting, yet the larynx will stand a surprising amount of rough handling without special objection.

To prevent recurrence, certain applications to the larynx are used, such as some of the more powerful astringents, or absolute alcohol. With the last mentioned agent the author has had more or less experience and under proper conditions is disposed to regard it with favor. In the case of a middle-aged lady who showed the larynx almost filled with papillomata so that on several occasions tracheotomy for relief of dyspnea seemed necessary, the tumors yielded to a combination of absolute alcohol with the use of the Mackenzie forceps, when under the forceps alone the growth would recur almost as fast as it could be removed. The extirpation of the tumors in this case was completed by T. H. Halsted, who reports favorably on the effect of alcohol instillations. The treatment with absolute alcohol is accomplished by means of a laryngeal syringe; not more than six or eight drops are applied at a time, the application being made every second day and after the use of cocaine. In one case, that of a child eight years of age, the alcohol seemed to excite an excessive degree of irritation and had to be abandoned. It was resumed after the lapse of a few weeks for the reason that no endolaryngeal manipulation was feasible without a general anesthetic. The first reapplication of the alcohol was followed within twenty-four hours by extreme stenosis from swelling which demanded a rapid tracheotomy.

Internal medication cannot be recommended with confidence. Improvement has been claimed by some from the use of full doses of arsenic, and following the suggestion of Kaposi as applied to cutaneous warts others have had good results with *Thuja occidentalis*. Small doses of protiodide or biniodide of mercury are advised by Watson Williams in the postoperative treatment and he also

speaks well of the local use of a 2 to 5 per cent. solution of salicylic acid in absolute alcohol, as proposed by Dundas Grant.

The use of the snare in the larynx is attended with some difficulty in adjusting the loop. In the case of cyst of the epiglottis already quoted which occupied the laryngeal face of this appendage the loop of the snare was readily engaged. Mackenzie's guarded-wheel ecraseur, or a similar instrument devised by Stoerk, is more serviceable than the unguarded snare.

The question of splitting the thyroid, or of opening the trachea, rarely arises except in children, in growths of unusual extent or dimensions, or in those which show a tendency to recur. My own experience with opening the trachea for removal of benign neoplasm is limited to the single case of subglottic myxoma in which I did a high tracheotomy. The operation was uneventful and its results were satisfactory.

In many instances spontaneous disappearance of laryngeal growths has been observed to follow the functional rest imposed upon the larynx by a tracheotomy. Lennox Browne calls attention to the danger in very young subjects of damage to the lungs attendant upon the sudden inrush through a tracheal opening of a large volume of air as compared with that habitually admitted through a larynx partially obstructed by neoplasm. If resorption of laryngeal growths may be reasonably expected after a tracheotomy, it would seem to be more judicious to adopt this alternative rather than expose the patient to the risks of endolaryngeal manipulation with its uncertain results in the early periods of life. In children, therefore, tracheotomy is often the operation of choice.

In the adult with multiple or very large neoplasms it may be a wise precaution to open the trachea before removal of the growth through the mouth is attempted. In some cases it is possible to reach portions of a tumor from below. The ingenious suggestion that tumors may be excised from the vocal bands by means of a fine-bladed knife passed through the cricothyroid membrane or through the thyroid cartilage at the level of the bands, as done by Rossbach in two cases, and guided in the proper direction by the aid of the laryngeal mirror held in the usual position, will hardly be regarded as generally feasible.

Kirstein's method ("autoscopy") by which the larynx is brought under direct inspection through forced depression of the tongue and

extension of the head, is available in some cases. Direct laryngoscopy gives a very clear view of the interior of the larynx, yet for routine work the older methods will doubtless be retained, straight instruments being reserved for manipulations in the lower air tract, where the most brilliant results have already been achieved. A general anesthetic is advantageous in children, although in most adult cases cocaine gives every facility. As a rule, general anesthesia, at least to a profound degree, is not to be recommended, or if the operator feels compelled to resort to it he should do a preliminary tracheotomy or be prepared to open the windpipe at a moment's notice.

Under the most favorable conditions the removal of a laryngeal neoplasm through the mouth with a curved or an angular instrument is a procedure demanding considerable dexterity. A growth at the anterior commissure and especially below the vocal bands is not easily reached; its structure may be so dense or its attachment so firm as to resist the action of a cutting forceps. At a first experience with forceps even in soft papillomata one is astonished at the toughness of the new growth and is tempted to relax the hold of the instrument in the fear that normal tissues have been seized. In the event of failure from inaccessibility of the tumor, as for instance when it is concealed beneath a vocal band, or in a ventricle of the larynx, or from any cause, the propriety of an external operation is suggested. Laryngofissure is not to be lightly advised both on account of the added risk involved in the operation itself, and especially because of the danger of permanent damage to the vocal function. Morell Mackenzie's dictum that "an extralaryngeal method ought never to be adopted unless there be danger to life from suffocation or dysphagia," is probably as true to-day as it was when uttered, but does not include a tracheotomy done in the hope of promoting resorption of the neoplasm. The conclusion of Bruns that the chief objection to an external operation lies in the danger of impairment of vocal function loses a measure of its force when we take into account the fact that the neoplasm itself is responsible for a large part of the damage. Moreover, in case it becomes necessary to split the thyroid in order to gain access to the growth a sufficiently accurate readjustment of the parts may be secured provided section of the cartilage is not made completely through its upper border. A point of far more importance and strongly favoring endolaryngeal

methods is the fact that recurrences have been much more frequent after thyrotomy than after the former.

In comparing the relative merits of intubation, endolaryngeal operation, thyrotomy, and tracheotomy enough experience has accumulated to authorize positive conclusions. Prolonged intubation, as pointed out by Wachenheim, is well known to be dangerous. The irritation caused by the tube provokes the formation of webs and adventitious bands and consequent stenosis. Two postdiphtheritic cases in my clinic signalize this danger. In each of these cases the larynx was split by Duel and after division of cicatricial bands beneath the vocal cords an intubation tube with a retaining arm or pin, like that suggested by John Rogers, was inserted. The final results were satisfactory, but the sojourn of the tube in these diphtheritic cases was even shorter than would be necessary in an average case of papilloma, a fact which discredits the feasibility of intubation in the latter condition. On the other hand, Robert Levy reports the case of a child four years old who wore a tube one hundred and eleven days almost continuously with the result of dispersing a collection of laryngeal papillomata.

In adults, and to a less extent in children, endolaryngeal operations have been found satisfactory, except in certain cases of relapsing papillomata. Ablation may have to be done over and over again and the growths are reproduced with amazing rapidity. It is said that Bond once operated on a girl of eighteen, who in ten years had been relieved of papillomata about every two months. Hovell operated under chloroform fourteen times on a boy three and a half years old. Stoker records a case of a man of thirty years with the unparalleled record of having submitted to 220 operations since seven years of age. Fortunately these histories are seldom repeated, and in these days with tractable patients and the aid of cocaine very different results may be expected.

As to thyrotomy in benign neoplasms of the larynx when we read of Walker Downie's case of six operations in one year, of Abbe's case of four thyrotomies, cauterization and tracheotomy, and of Lendon's seventeen thyrotomies in two years followed by stenosis and a permanent trachea tube we are quite prepared to pronounce sentence of banishment upon this procedure. It is high time to discard an operation that is not only more or less hazardous, but gives no assurance of curing the disease for which it is performed.

Turning to tracheotomy we find a far more encouraging showing. The reports of Hunter Mackenzie, Massei, Garel and many others establish the fact that the physiological rest given to the larynx by making a tracheal fistula determines a disappearance of laryngeal papillomata in from six weeks to five years. This occurrence has been observed so often that tracheotomy must be considered the classical mode of treating papilloma of the larynx in very young children, while in older subjects the tracheal opening permits a resort to endolaryngeal manipulations with deliberation and without danger.

In all cases of benign neoplasm in the larynx it is essential to pay attention to the condition of the upper air-tract and in every instance make sure that the nasal cavities and the nasopharynx are free from obstruction. In the opinion of many lymphoid hypertrophy in the latter situation is a very frequent cause of neoplastic formation in the larynx. Lennox Browne held this view, while Shurly declares that he has never met with a laryngeal papilloma in one having at the same time adenoids in the pharyngeal vault. It cannot be supposed that nasal, or pharyngeal, diseases are the sole cause of laryngeal neoplasms, but on the ground that the former increase the susceptibility of the passages below their elimination is certainly indicated.

The after-treatment in these cases of operation for laryngeal neoplasm consists in the adoption of bland and soothing sprays for the correction of a catarrhal condition, and the enforcement of absolute rest. To prevent recurrence Fauvel advises insufflation of equal parts of savine and alum. Astringent sprays are useful and in several cases sprays of alumnol have seemed to me particularly effective. In case of violent postoperative reaction it is necessary to resort to methods used in controlling simple inflammation of the larynx as already described. As a matter of fact acute inflammatory stenosis following an operation within the larynx is extremely unusual, and the less interference during convalescence the better.

CHAPTER XX.

MALIGNANT DISEASE OF THE LARYNX.

SARCOMA OF THE LARYNX.

Sarcoma of the larynx is an embryonic *connective* tissue growth, and may be met with at almost any period of life. Bosworth has collected 47 cases of sarcoma of the larynx, the youngest being nineteen, the oldest 75 years of age. It is therefore not a frequent lesion and there is no evidence of heredity. So far as can be determined there is no reason to believe that local inflammation exercises any predisposing influence. It may remain limited to the larynx for a considerable time, and, only after a long period may extend beyond the cartilaginous walls to involve the external structures and the lymphatic glands. In a case under my own observation a trachea tube was worn for two years without marked progress of the disease. It usually occurs as a uniformly round tumor which

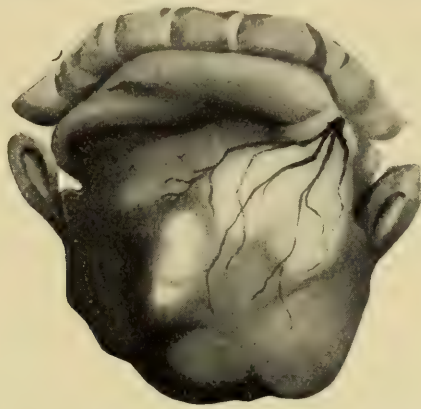


FIG. 126.—Sarcoma of Larynx. (*Chappell.*)

seldom ulcerates though its surface may become eroded. Occasionally it is nodular and shows a tendency to extend downward into the trachea. In many cases a microscopic examination is necessary to determine its character, but it is often difficult to get satisfactory sections for the purpose. In more than half the cases the vocal bands themselves were involved; next in order of frequency the ventricular bands and, in two cases, the epiglottis

(Fig. 126). Both round- and spindle-celled forms of sarcoma have been met with in the larynx, as well as lymphosarcoma, fibrosarcoma and myxosarcoma, primarily, or by extension from adjacent parts.

The symptoms depend upon the size and location of the tumor. Usually hoarseness, cough and dyspnea are present, but there may be no pain. There is seldom any severe hemorrhage but the sputum may be tinged with blood. The tendency to generalization is very tardy. The cervical glands are rarely involved owing to obliteration of the lymphatics by cell proliferation. Cachexia is not marked and does not develop until the laryngeal disease has existed for a long period.

The prognosis of sarcoma of the larynx is bad. In the majority of cases we are compelled to choose between a tracheotomy for the relief of laryngeal stenosis and *complete extirpation*. The latter must be regarded in most cases as merely postponing an inevitably fatal result. In a few cases of partial extirpation for very limited disease the operation has been successful. The mode of operating depends upon the size and situation of the tumor. Out of twenty-one cases of operation through the natural passages by the forceps, snare or knife collected by Bosworth, six were cured, eight were improved, two recurred, four were fatal, and in one there is no record of ultimate result. Whatever external operation is undertaken it is desirable to do a preliminary tracheotomy. One is often disappointed to find on splitting the larynx that the disease is much more extensive than it appeared in the mirror, so that what promised to be a partial extirpation must be converted into a complete laryngectomy.

CARCINOMA OF THE LARYNX.

For many years the terms sarcoma and carcinoma were used interchangeably to indicate malignant disease. Confusion on this point has been largely dispelled by limitation of the term carcinoma to *epithelial* tissue growth.

Cancer of the larynx may be extrinsic, intrinsic, or both combined. Krishaber includes in the first those lesions involving the epiglottis, the arytenoids, the aryepiglottic folds and the pyriform sinuses, and in the second those springing from the vocal bands, the ventricular

band, the ventricles and the region of the larynx below the vocal bands.

Among carcinomatous lesions epithelioma largely predominates, although cases of medullary cancer and scirrhous have been recorded (Fig. 127). Its rarity is evidenced by the fact that in 11,131 cases of cancer collected by Gurlt only 63 of the larynx were found. Hereditary influence was thought to have been discovered in about 25 per cent. of the cases, and the disease is frequently traced to overuse of the voice. There is usually a history of chronic laryngitis preceding the development of the neoplasm. It is essentially a

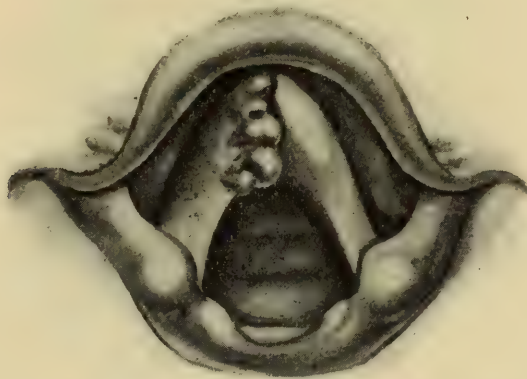


FIG. 127.—Epithelioma of Right Vocal Band at Anterior Commissure.
(Schnitzler.)

disease of middle life and of old age, but one case on record occurring in a child. It generally involves a vocal band, and until a very advanced period of development remains intrinsic. Glandular infiltration in intrinsic disease is rather a late phenomenon, the lymphatics in the interior of the larynx not anastomosing directly with those of the exterior (Fig. 128).

The earliest symptom in the majority of cases is impairment of voice. It is generally progressive until complete aphonia becomes established. Dyspnea is seldom marked at an early stage. The characteristic cachexia sometimes develops rather early. The patient presents a grayish-yellow complexion, his features become shrunk, and he has the appearance of premature old age. The glands in the neck sooner or later begin to show signs of infiltration, those near the cornua of the hyoid bone being first affected. The breath becomes fetid, especially in the event of ulceration, more or less expectoration occurs, frequently stained with blood, or profuse hemorrhage takes place. Sharp pain, lancinating in character

and radiating toward the ear of the affected side is regarded as pathognomonic, but is not unknown in other conditions, and is often not a prominent symptom in cancer.

An ulcer of the vocal band in the neighborhood of the vocal process surrounded by a livid red areola, and associated with more or less thickening and with decided impairment of mobility of the corresponding side of the larynx, occurring in a person of middle age or older, must be looked upon with suspicion. It is not always possible or justifiable to remove a sufficient piece of the ulcer or

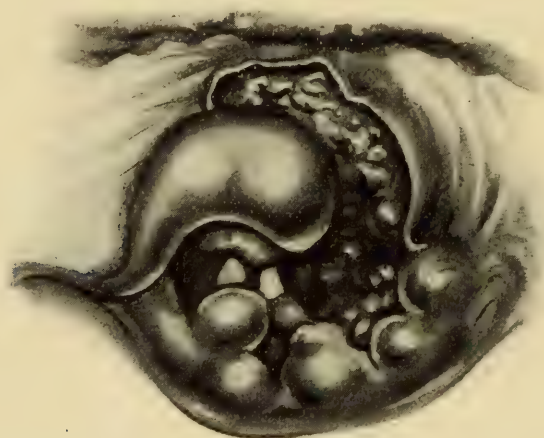


FIG. 128.—Advanced Cancerous Ulceration Left Side of Larynx.
(Schnitzler.)

neoplasm for microscopical examination; a superficial section of the growth often gives misleading or negative testimony, and the manipulations necessary in order to secure a specimen are apt to stimulate development.

It has been a frequent experience to rely upon the microscopical diagnosis in doubtful cases and to make all preparations for a radical operation, when unexpected amelioration in the local condition took place and finally the lesion disappeared altogether. Several years ago a middle-aged man came into my service at the Manhattan Eye, Ear and Throat Hospital with a clinical history of epithelioma of the larynx. He had been under treatment at another hospital, where it was reported that the microscope had pronounced the lesion to be epithelioma. A preliminary tracheotomy was done from which the patient made a good recovery, with the expectation of undergoing laryngectomy a week later. In the meantime he changed his mind and refused to submit to radical interference.

He left the hospital and was not seen again until a year afterward when he returned with voice almost completely restored and with hardly a trace of infiltration in the larynx at the site of the supposed epithelioma. The case recited is, by no means, an unusual one, and illustrates the difficulty in making a positive diagnosis from the microscopic examination of a small fragment removed *per vias*

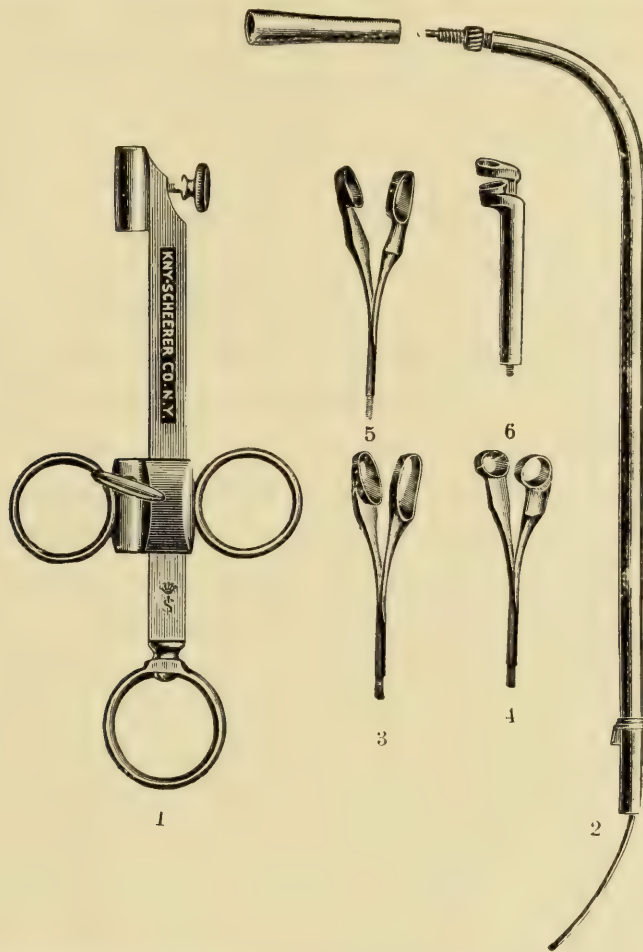


FIG. 129.—Krause's Laryngeal Set, 1, 2 and 3; Heryng's Curettes, 4 and 5; Landgraf's Curette, 6.

naturales. One may more readily appreciate this fact when recalling the various appearances presented by different parts of a complete section of a morbid growth. In a recent case of thyrotomy for epithelioma of the larynx all the diseased tissue removed was divided into two portions and one sent to each of two competent microscopists. Their reports were absolutely contradictory. Such an experience is no discredit to the microscope, but its negative testimony should be accepted with hesitation in the face of positive or even suspicious clinical signs. Many authorities rely confidently upon the micro-

scope and attribute its failure to give definite evidence to the use of an inefficient instrument in cutting out a piece. Moritz Schmidt, for example, insists that a double curette like that of Landgraf (Fig. 129) which cuts out a large thick segment of tissue must be used. This observer also calls attention to several rare forms of cancer especially difficult of recognition. While it usually appears as a well-defined tumor, it may have its origin in the deep tissues and give rise to a proliferating or vegetating condition on the surface of the mucosa closely resembling papilloma. Again the picture of malignant disease seated in the ventricle of Morgagni may simulate that of a perichondritis, or a cancerous mass at the posterior wall or below the cricoid may involve the recurrent nerve and thus its first symptoms are those of laryngeal paralysis. He relies upon iodide of potash to exclude syphilis in doubtful cases and lays great stress upon the *yellowish white color* considered pathognomonic of a cancerous lesion as well as upon the fact that the latter seldom develops primarily at the posterior part of the vocal bands. Felix Semon describes a snow-white, sharply pointed lesion, resembling a papilloma, but less bulbous and rounded, as "extremely suggestive of malignant disease." The same authority gives interesting details of a case seen by himself and several other eminent surgeons in which the clinical history of cancer was almost unequivocal. A tracheotomy preparatory to a complete extirpation disclosed a number of apparently infected glands and the major operation was abandoned. A year later the patient reappeared still wearing his trachea tube but with no trace of glandular infiltration and no laryngeal stenosis. It seemed that in the meantime he had been taking Clay's mixture of Chian turpentine, a preparation that once had quite a reputation as a specific in cancer. Semon attaches no importance to the use of this article, but holds the view that the case was really one of syphilitic perichondritis and that the glandular swelling was purely inflammatory. Iodide of potassium was given without result when the case was first seen and unfortunately the glands removed at the operation were not examined microscopically, so that the nature of the lesion remains in more or less doubt.

The diagnosis of carcinoma of the larynx in its early stage is extremely important, since it is only at this period that we may hope to do anything in a surgical way. The tumor may be seated at a point where a radical operation would certainly include it all. Hence

if the parts can be exposed in the early period of development we may succeed in eradicating the disease. The propriety of attempting to exclude certain other diseases by tentative treatment always suggests itself. The tuberculin test is of service as regards tuberculosis. In using iodide of potash in order to eliminate syphilis, large doses must be given. Amelioration in many ulcerative conditions occurs at the first administration of this drug, whereas no impression whatever is made by it upon that rare form of fibroid degeneration sometimes occurring in old syphilis. Moreover complications may arise from the coexistence of syphilis or tuberculosis with cancer. Under such circumstances a syphilitic history or the discovery of tubercle bacilli may divert us from the more serious lesion. According to modern views the presence of the "spirocheta pallida" is unmistakable evidence of syphilis. It is difficult if not impossible to demonstrate in the late stages. The skin and ophthalmic tuberculin tests commend themselves by their simplicity, but they are not infallible and they are not certainly free from risk. Transillumination and the Roentgen ray have been used to demonstrate an area of infiltration. The results they give are of but little value, since by the time an infiltration has become extensive and dense enough to give decided reaction other evidences are sufficiently pronounced.

Treatment may be palliative or radical. In case radical interference is not feasible or be declined, we are compelled to meet the various symptoms as they arise. The most distressing symptom in the final stages if not at the outset is pain. As a last resort we have morphine in some form, either hypodermically or by the mouth, but it is well to try first the effect of various local anesthetics. Temporary relief is obtained from applications of morphine, 4 grains, tannin and carbolic acid, each 30 grains, in half an ounce each of glycerin and water (Ingals). A solution of carbolic acid, 1 1/2 dr., tinct. iodine 4 dr., and glycerin 2 dr., has been found serviceable in mitigating the pain of an ulcerative lesion in malignant disease as well as in syphilis. A considerable degree of comfort is given in the early stages by spraying with cocaine in 10 per cent. solution, or stronger. Several hours' respite from pain may be secured by thorough insufflation with orthoform-new. If applied after cocainization a certain quantity is likely to be retained in contact with the ulcerated surface.

Liégeois reports good results from the internal administration of *Thuja occidentalis*, as well as from local application of the same drug. In a case of recurrent epithelioma of the larynx, after an operation by Kraus, the patient was given Fowler's solution of arsenic. During this course three pieces of the tumor were coughed up and death finally occurred from intercurrent pneumonia five and a half years after the tracheotomy, the neoplasm having apparently disappeared. The favorable reports of such treatment might be thought to throw suspicion upon the diagnosis. Experience with "trypsin," a pancreatic enzyme highly commended by John Beard, of Edinburgh, and with Doyen's *micrococcus neoformans*, on which a somewhat favorable report has been made by Spicer and Wright, is still too limited to justify a final opinion. One who has much to do with malignant disease meets with cases in which the clinical history, very likely confirmed by histological evidence, has proved delusive. Hence the utmost caution should be exercised in our attitude toward the alleged "cancer cures" now and then foisted upon a gullible public. If a case of malignant disease recovers we are apt to jump at the conclusion that the diagnosis was erroneous, yet there is reason to believe that spontaneous resorption of malignant growths does in rare instances take place. Conversion of metastatic deposits into fibrous tissue, after removal of a primary tumor, has been observed, and prolonged quiescence or even retrogression of disease after partial operation is not unknown, although an exception to the rule.

The surgical treatment of cancer of the larynx may be conducted through the mouth or by external operation.

The endolaryngeal method is supported by a number of successful cases reported by B. Fraenkel. In one case in which a neoplasm was extirpated with the galvanocautery loop five recurrences took place. In one the cervical glands had to be removed by repeated external operations. The importance of constant watchfulness is insisted upon, so that the time for an external operation, should it prove to be imperative, may not be permitted to pass. Allowance must be made for the unusual diagnostic acumen and manual dexterity of this operator. Up to the present time about 50 cases of endolaryngeal operation by various surgeons have been reported showing a record of recurrence in 37 per cent. and of cure in 40 per cent. (Sendziak). Successful cases have been reported by Mermod

and Kraus, the latter observer very properly limiting the endolaryngeal operation to polypoid and circumscribed cancers. One of the firmest advocates of endolaryngeal extirpation is Jurasz, who restricts the method to the first stage when functional disturbance is slight and the disease is local and circumscribed. He thinks well of the electric cautery, but prefers excision by means of a punch forceps of his own design. From a thorough review of this subject Gouguenheim and Lombard conclude that the endolaryngeal route is *not* available for cancers even of limited extent. They express decided preference for partial laryngectomy in operable cases. It would be unfortunate if the results first quoted should unduly inspire the zeal of surgeons in this direction, lest improper cases be selected for endolaryngeal operation and thus valuable time be lost. The majority of cases apply for advice so late that relief of symptoms by the use of local applications and, if necessary, the introduction of the trachea tube, comprise all that we are justified in doing. In a small proportion in which an early diagnosis is positive and in which the disease is known to be distinctly circumscribed fissure of the larynx with thorough removal of the soft parts involved and beyond, offers some hope. The objects in view are in the first instance to eradicate the disease, and if that is not feasible to add to the comfort and prolong the life of the patient. The latter course may seem less humane than a well-directed euthanasia, yet public sentiment does not permit us to treat the human subject with the consideration we apply to the lower animals under similar circumstances. Cases in which the disease is progressive and has invaded the larynx so far as to necessitate *complete* removal of that organ with its cartilages and the adjacent glands, are not good subjects for radical interference. The probability is very strong that the disease has by this time crept along some lymphatic channel beyond the reach of the eye where it will escape the knife, and become a focus for recurrence within a short time. The opinion is expressed by Hartley that although the mortality is high and permanent cures few total laryngectomy is justifiable. With increased accuracy in diagnosis and improvement in operative technic the results hitherto far from reassuring may become more favorable. Glück, of Berlin, attributes his exceptional success to prevention of aspiration pneumonia by a preliminary resection of the trachea, the air-tract being thus absolutely isolated

from the site of operation. In view of the fact that the laryngeal tissues are enclosed in cartilaginous walls, through which no lymphatics pass, the chances of recurrence after removal of cancer of the larynx strictly *intrinsic* are less than in other situations. There is a marked difference between intrinsic and extrinsic cancers in the greater tendency of the latter to involve the cartilage as well as the lymphatics, a point which has a very serious bearing on the prognosis and the mode of operating. Watson Cheyne and other authorities regard sepsis as the most important factor in mortality from the operation. A careful observance of all precautions and a judicious selection of time and method of operating will surely reduce the danger from this source. Desirable conditions as to the patient are enumerated by Delavan as follows: He should not be too old, he should be possessed of good vitality, he should suffer from no physical defect that may retard recovery, and his temperament, intelligence and surroundings should be favorable to a comfortable existence after operation. The personal equation is perhaps too little considered. It is a notorious fact that certain individuals go through the most formidable surgical procedures with equanimity while others collapse under a comparatively trifling ordeal. To some the loss of an important organ with deprivation of vocal function is intolerable. Confirmed melancholia and suicidal tendency have been known to develop after complete laryngectomy. The various artificial devices for supplanting the human larynx, while most ingenious and interesting, are poor imitations of the original mechanism, and to many would seem impossible. The kind of voice cultivated by several subjects whose larynx had been removed for cancer in such a way that communication between the lungs and the pharynx was entirely closed cannot be considered very satisfactory. In discussing operative interference in a given case the patient should be taken into our confidence and the ultimate decision left in part at least to him after a fair presentation of the question.

The rule applied to malignant disease in general should be rigidly enforced as regards cancer of the larynx, that is, the extirpation should include a wide area of adjacent healthy tissue and every suspicious lymph gland and channel. Unfortunately, the average American will hardly bring himself to submit to the mutilation involved in the application of this principle, especially since even

thus absolute certainty of immunity cannot be ensured. He will prefer rather to accept the comfort afforded by anodynes and a tracheotomy, when compelled to face that necessity, and in the meantime get what pleasure he may out of life. In an eloquent and forceful plea for early naked eye diagnosis of cancer of the larynx and complete laryngectomy a distinguished authority, J. N. Mackenzie, has made the admission that there is no single unequivocal laryngoscopic sign of cancer. A conclusion must be reached from a study of the congeries of symptoms, local and general, subjective and objective. Excision of a piece of suspected tissue for microscopic purposes, except as a very final resort, is objectionable because (1) it opens the way to autoinfection and metastasis, (2) it stimulates the growth of the cancer, and finally (3) it is often inconclusive, misleading, and is sometimes practically impossible. It is not an uncommon experience for a laryngeal neoplasm previously benign in appearance and clinical history to suddenly undergo absolute change of behavior after attempts at removal for curative or diagnostic purposes. As a general rule growths of the larynx of doubtful nature, especially in middle-aged or older persons, should not be tampered with unless we are prepared to meet this contingency. It is not my purpose to discuss the various methods of performing excision of the larynx. Our patients are entitled to all the art and skill bestowed by constant familiarity with the details of surgical technic. Hence it becomes our duty to secure the counsel and assistance of the general surgeon in these cases. It remains the business of the specialist to cultivate the utmost proficiency in identifying the early symptoms of laryngeal cancer before the disease has become inoperable. The proposition made several years ago by H. T. Butlin to do an *explorative* laryngofissure in every case of tumor of the larynx suspected of malignancy has not met with universal favor. Should it be accepted as a justifiable diagnostic resource it would seem wise never to undertake it without a distinct understanding that the operator be authorized to proceed to any extent indicated by the character of the neoplasm thus exposed. The opinion is expressed by Semon that while it is not free from risk the dangers of splitting the thyroid are almost always avoidable. The fact has often been noted that the disease is invariably found to be more extensive than it appeared to be in the laryngeal mirror. Therefore the wisest policy seems to be to place our reliance on other means

of diagnosis and resort to a thyrotomy only when we are prepared to go to the full length of surgical interference.

The technic of thyrotomy as perfected by Butlin, Semon and others gives a rather favorable showing as regards mortality. Yet even in the most skillful hands fatalities occur, and the preliminary tracheotomy, considered essential, is neither so easy, especially when the trachea is entered below the isthmus, nor so safe as is often represented.

In a review of the statistics of thyrotomy by Ernest Waggett, based upon the experience of the surgeons just mentioned, the superiority of laryngofissure over total extirpation in the three particulars of (1) preservation of function, (2) death rate from the operation, and (3) exemption from recurrence seems to be clearly established. He comments adversely on Mackenzie's demand for extensive operation in malignant disease of the larynx both on account of the deplorable state in which the patient is left and chiefly because it offers no security against recurrence. Sendziak, who has investigated this subject most carefully, has tabulated 875 cases operated upon by the endolaryngeal method, by thyrotomy, by partial and by complete excision. He regards operative interference with favor and believes thyrotomy to be by far the safest and most promising method. His figures for the last 20 years show 54 per cent. of cures by thyrotomy and only 23 per cent. by total laryngectomy. The value of these statistics is especially doubtful, since total extirpation is done only in the last extremity, yet the comparative mortality with thyrotomy is much less.

Many malignant tumors of the larynx develop slowly, as declared by Ruault, seven or eight years passing without very pronounced change. With this fact in mind and viewing the disappointing results of radical intervention, it may be worth while to consider measures for controlling the nutrition of the affected region, either by such a procedure as ligation of the arteries supplying the larynx after the method of Dawbarn, or by the frequent application of agents like adrenal extract whose ischemic power is well established.

It remains to be seen whether phototherapy, which has been tried with a promise of success in tuberculosis as well as in superficial forms of external cancer, is capable of exerting an influence upon the less accessible type of malignant disease as developed in the larynx. The remarkable success with radium gained by Abbe in cancers

nearer the surface of the body has not yet been duplicated in the larynx. Some of the cases reported as having been treated with the X-ray showed more or less improvement, but unfortunately in some the diagnosis was not confirmed by the microscope, and the accuracy of a diagnosis based on clinical history is open to question. The "fulguration" treatment with high frequency currents (d'Arsonval, 200,000 to 300,000 volts) following surgical removal of as much as possible of the tumor (De Keating-Hart) seems to have been moderately successful in superficial cancers but is hardly practicable in the larynx. Navratil is responsible for the statement that the Roentgen rays when used in the larynx may induce an irritative and even dangerous effect on the vagus. Delavan asserts that not a single authentic case of cure can be found, but he believes in the extraordinary possibilities of the method and that in every case of reputed cure sufficient time should be allowed to elapse to prove its permanency. It seems fair to conclude that all cases manifestly inoperable should be allowed the chance it offers.

CHAPTER XXI.

TUBERCULOSIS OF THE LARYNX.

Tuberculosis may attack the larynx primarily or secondarily; in the former case, the process is usually acute; in the latter, chronic.

Primary tuberculosis of the larynx is believed by some authorities to be not very uncommon and is thought to have certain distinguishing characteristics. According to Bernheim, in the beginning milary granulations are seen in the arytenoid region accompanied by a general laryngitis of mild grade. Finally ulcers form which take on a vegetating or papillomatous character. Tubercle bacilli are found in the sputum or in scrapings of the ulcers, sometimes only after careful and prolonged search. Twenty-nine cases of primary tuberculosis of the larynx have been reported by Aronsohn, three of which are authentic, in seven the coincident pulmonary lesion was limited and believed to be secondary, while in nineteen the diagnosis of primary laryngeal disease was based solely on clinical signs, which of course cannot be accepted as conclusive. Opportunities to verify a diagnosis are rare because death seldom occurs until the presence of the disease in other situations is manifest. Early identification is obviously important, in order by suitable local treatment, diet and hygiene to prevent the disease from becoming generalized. Some authorities also recognize a *pretubercular* or prebacillary state in which no positive signs of tuberculosis can be discovered either in the lungs or larynx. At this time the larynx is free from ulceration and infiltration, but, as pointed out by Ringk, may be anemic or hyperemic. The former is usually characteristic of a chronic, the latter of an acute process. The propriety of adopting this term is doubtful, unless it is intended merely to indicate a predisposition or a state of lessened resistance. Weakness of the voice amounting at times to partial aphonia, subnormal morning temperature with more or less rise the latter part of the day, associated with anemia of the larynx or possibly a circumscribed hyperemia of one vocal band, should always excite apprehension, even though cough may be moderate, sputa scanty, and tubercle

bacilli not found. The depth and limitation of an incipient pulmonary lesion may prevent its detection by physical signs. We may not be justified in pronouncing such a case one of tuberculosis, yet steps should be taken to bring about an improvement in the local conditions which will tend to diminish a susceptibility to infection. This especially refers to use of the voice and to intimate association with others known to be infected. The family history and the question of heredity are concerned so far as these factors are capable of impairing constitutional vigor and power of resistance. In accordance with modern views we are not authorized in condemning an individual because his ancestors had tuberculosis. An inherited tendency, if such a thing exists, may almost surely be corrected under favorable conditions and in a climate which permits continual life in the open air. Unfortunately the prescribed treatment and regime must often be carried out under most adverse circumstances.

As to etiology, any condition, local or general, which favors the growth of the tubercle bacillus, may invite the disease to the larynx. Low vitality combined with the existence of a catarrhal state of the mucous membrane affords predisposition. We find laryngeal tuberculosis more frequently in the male sex than in the female for the reason that the occupations of men expose them more generally to the exciting causes. It is most likely to develop between the ages of 20 and 30 years.

Subjects of tuberculous laryngitis are liable to intercurrent attacks of simple inflammation, and are prone to exhibit temporary improvement in summer, in mild weather and under change of climate. The frequency of the disease is very startling. Heinze, of Leipsic, reports 4,486 autopsies, in 1,226 of which tuberculosis was found; of the latter 51.3 per cent. showed laryngeal lesions, more than one-half being ulcerative, a proportion confirmed by the statistics of the Brompton Consumption Hospital but nearly twice as large as that admitted by many investigators. The mode of invasion of the larynx is either by direct infection through the inspired air, by the expectorated sputum, or indirectly by conveyance of bacilli from tuberculous foci in the lungs through the blood current or the lymph channels. Various theories have been propounded to explain the comparative immunity of the larynx. It is said that the bacillus of Koch, which is supposed to be the essential element in infection, requires not only suitable soil but a quiet resting place for its development, and

that abrasions of the mucous membrane of the larynx, which might permit the entrance of the bacillus, are promptly protected against it by the formation of exudate or granulations. E. L. Shurly, who expresses skepticism as to the importance of the part played by bacilli in infection, combats the foregoing views and calls attention to the fact that while some parts of the larynx are almost never at rest the ventricles are certainly sufficiently quiescent and secluded as regions for the lodgment and cultivation of germs. There is no reason to believe that the laryngeal mucosa differs from similar tissue elsewhere in its defensive power. As to the bacillus, while it has been proved to retain its vitality in a bronchial gland in a state of latency for twenty years, it has also been demonstrated that some tuberculous lesions contain no bacilli. The majority of observers will probably agree with Delafield and Prudden that the effect of the bacilli is governed by their number and virulence, by the nature of the tissue in or upon which they rest, and by the vulnerability of the individual. Although some authorities deny that mouth breathing is a factor in infection, it is believed that the importance of nasal stenosis as favoring derangements of any kind in the lower air tract should not be underestimated. Yet it must be considered injudicious to undertake operative measures for the correction of nasal atresia in a tuberculous subject unless it is quite certain that his vitality is capable of withstanding the additional drain.

The pathological changes characteristic of laryngeal tuberculosis consist of cellular infiltration and edematous phenomena, together with tubercle bacilli, especially in the miliary form associated with ulceration or caseation. In the early stage the capillaries are engorged, the tissues are crowded with leucocytes and small round cells, the glands are distended with serum and cells and finally become obliterated. Nodules of granulation tissue appear, and feeble attempts at organization are seen, but finally necrosis, softening and ulceration take place. The breaking down process begins in the deeper layers, thence extending to the surface of the mucous membrane, or to the perichondrium, in the latter case sometimes involving the cartilage itself. Tuberculous foci are identical with those found in other situations, consisting of scattered masses of large epithelioid cells, usually enclosing one or more giant cells, embedded in a zone of granulation tissue and surrounded by loose irregular small cells of infiltration tissue. In localized disease a

compact wall of cells and fibrous connective tissue surrounds the morbid deposit. The tubercle is not vascular and bacilli may be found both within and without the cells. The secretion of a tuberculous ulcer is found to contain disintegrated epithelial cells, mucus, a small amount of pus, and generally tubercle bacilli. Free pus formation is not a usual feature.

The early *symptoms* of laryngeal tuberculosis relate chiefly to the voice. There is more or less huskiness, the voice becomes low pitched, and attempts at loud phonation may result in *diphonia*, or double voice. The impediment to breathing is not, at the onset, at all marked, although respiration may be labored and more or less stridulous. The amount of sputa is not excessive until the lungs become involved to a considerable extent. There is little or no trouble in swallowing until the late stages of the disease when deglutition may become not only difficult but painful. The impediment to swallowing is due either to simple inflammatory swelling especially of the posterior laryngeal wall, to involvement of the perichondrium or cartilages themselves, or to more or less extensive ulceration. In the early stages there is little or no pain, although the patient complains of a sensation as of a foreign body, or simply a feeling of uneasiness or dryness. There is more or less external tenderness on pressure over the thyroid cartilage. One of the most distressing and persistent symptoms even at the beginning is cough. The cough of laryngeal tuberculosis is most marked in the morning and when the patient first assumes the recumbent position at night.

The *diagnosis* of laryngeal tuberculosis in typical cases is free from difficulty. There is hardly any laryngeal disease, however, which presents so many variations from what we are accustomed to call the typical form. In the early stages of the disease, a feature by no means invariable, which strikes us with most force in the laryngeal mirror, is the *pallor* of the mucous membrane. This is especially marked in the chronic form and is not proportionate to the degree of general anemia. Infiltration and tumefaction are observed particularly in the interarytenoid space and of the ary-epiglottic folds. The normal prominences of the arytenoids are effaced by a pyriform swelling involving both sides of the larynx and usually quite symmetrical. They assume the so-called "club-shaped" contour (Fig. 130). The epiglottis may be infiltrated and swollen, or "turban-

shaped." In exceptional cases the infiltration of the larynx is unilateral, and thus the uncertainty of diagnosis is much increased (Fig. 131). The mucous membrane has an edematous, soggy look. The movements of the arytenoids are interfered with by infiltration



FIG. 130.—Tuberculosis of Larynx. Clubbing of Arytenoids and Papillary Excrescences at Posterior Commissure. (*Schnitzler.*)

of the muscles or possibly by an inflamed cricoarytenoid joint. The importance of the latter has been especially insisted upon by W. Fowler, who in upward of fifty autopsies found implication and more or less disorganization of the joint in every instance. Aphonia is due to this cause, or simply to a general weakness of the intrinsic

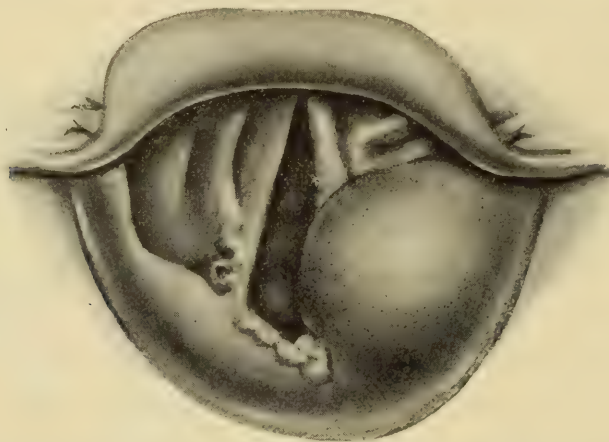


FIG. 131.—Tuberculous Ulcer with Extreme Swelling of Left Arytenoid. (*Lennox Browne.*)

muscles of the larynx, or to an intercurrent laryngitis. When there is apparent unilateral paresis it is generally observed upon the right side and is due to involvement of the right recurrent nerve by pleuritic adhesions, consolidation of the right apex, or pressure from

bronchial glands. Ulceration is met with in late stages and is due to a breaking down of small tuberculous foci which coalesce, giving the ulcer a characteristic *worm-eaten* or nibbled margin (Fig. 132). Superficial erosions resembling aphthæ may occur. Necrosis and caries are not uncommon and may involve almost any of the

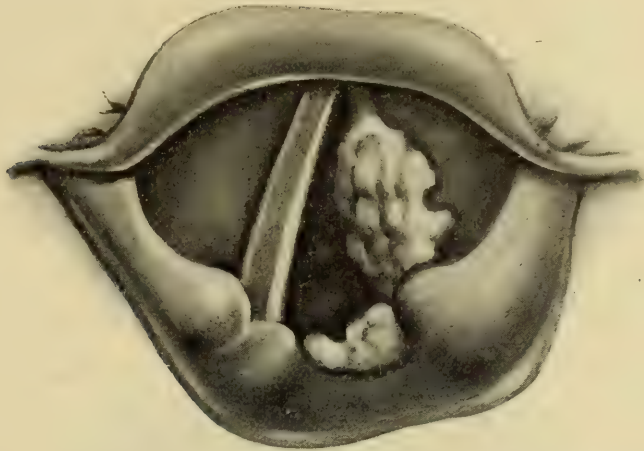


FIG. 132.—Tuberculosis of Larynx in Ulcerative Stage.
(Lennox Browne.)

cartilages. Among the unusual forms of tuberculous development within the larynx are what have been designated granulomata, papillary excrescences at the posterior commissure, and distinct tumors or nodules, usually rounded and smooth and covered by mucous membrane not differing from that of other parts of the larynx (Fig. 133). These tumors sometimes soften and ulcerate,

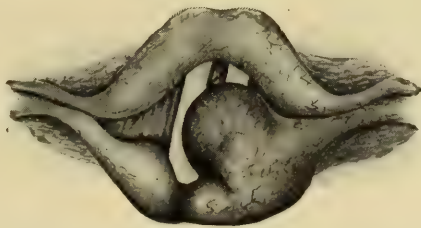


FIG. 133.—Tuberculous Tumor of Larynx. (Rice.)

and are most frequently seen on the lateral wall of the larynx, or in the trachea. They have been carefully studied by J. N. Mackenzie, who was the first to describe a genuine tuberculous tumor of the trachea, consisting of miliary tubercles embedded in a vascular network of connective tissue. Wart-like growths between the arytenoids are occasionally seen in syphilis and in chronic laryngitis,

but point to incipient tuberculosis when associated with pallor of the mucous membrane or suspicious pulmonary signs. Granular hyperplasiæ at times reach a considerable volume, especially when springing from the margins or base of an extensive ulceration. They usually shrink before offering any serious impediment to breathing. The contrary was true in a case once reported by the author, that of a boy twelve years old, in whom laryngeal stenosis from tuberculous granulomata demanded an intubation and finally a tracheotomy, death occurring a few weeks later from general tuberculosis. The youth of this patient and the presumption that it is an instance of primary laryngeal tuberculosis give the case especial interest (Fig. 134).



FIG. 134.—Tuberculous Ulceration at Posterior Commissure and Vocal Processes. (Schnitzler.)

The symptoms of general tuberculosis, anorexia, emaciation, hectic, rapid pulse, night sweats, cough with expectoration, and possibly hemoptysis are marked in proportion to the degree and activity of pulmonary involvement. Nutrition may be interfered with by a very extensive laryngeal lesion before signs of pulmonary disease are in evidence.

A differential diagnosis must be made from cancer and syphilis. Confusion is not likely to arise from other sources. In *cancer* there is sooner or later marked cachexia, more or less constant pain, frequently shooting toward the ear of the affected side, aggravated by swallowing and more intense when fluids are taken. The lesion itself begins as a neoplasm, later becoming a deep, ragged ulcer coated with grumous, fetid secretion and surrounded by a livid or purplish areola. The mobility of that side of the larynx affected is impaired

early by the infiltration. The voice is lost and stenosis may be extreme. In *syphilis* the voice is hoarse and low-pitched, but complete aphonia is rare until late destructive ulceration or cicatricial contraction occurs. The latter condition may also cause excessive dyspnea. The ulcer itself is comparatively free from pain, and the constitutional symptoms are, as a rule, unmistakable. The lesion is usually clean cut with raised indurated edges and covered with necrotic detritus. Characteristic scars in the pharynx or elsewhere, or traces of the disease at some other part of the body, even in the absence of a history, or of active symptoms, will usually solve the problem. The greatest perplexity arises in connection with latent syphilis, or "*syphilis ignoré*," and in cases of mixed infection. An example of the latter in my own experience was betrayed by typical ulceration of the fauces which healed under mixed treatment leaving characteristic scars. The patient had already been sent to a mild climate for tuberculosis, the latter diagnosis having been based on pulmonary and general symptoms confirmed by tubercle bacilli in the sputum. Lupus, glanders and leprosy, all very rare diseases, may simulate the local appearances of tuberculosis, but the history of these is usually conclusive. In exceptional anomalous cases the diagnosis must be held in abeyance almost indefinitely. Pulmonary disease may be so deep-seated, or limited, as to give no signs, and, moreover, infection may take place in the larynx and may remain localized in that organ for a considerable time. In very rare cases of chronic laryngitis hypertrophy of the mucous membrane is so extreme as to resemble a tuberculous infiltration, but such a condition usually occurs in those whose occupation and habits account for the extraordinary thickening. The Roentgen ray bids fair to give positive testimony long before subjective pulmonary signs appear, and finally the ophthalmic and cutaneous tuberculin tests will help to remove doubt.

In the laryngeal mirror the characteristic appearances of a tuberculous larynx are the semi-solid, edematous infiltrations or the "worm-eaten" ulceration involving the epiglottis, the arytenoids, or the aryepiglottic folds. Usually the lesions are symmetrical or bilateral. The ulcer of tuberculosis is covered with pale granulations, its floor is not deeply excavated, and its edges are irregular and nibbled, owing to the confluence of small marginal ulcerations and breaking down of minute tuberculous foci. There is seldom an

areola as in cancer and syphilis; on the contrary, the surrounding parts are pale.

The *prognosis* in tuberculous laryngitis is admittedly bad, but by no means hopeless. Life may be threatened by suffocation, by inanition, or death may occur from hemorrhage, yet the laryngeal lesion itself is seldom fatal except as it may interfere with the patient's nutrition through inability to swallow. Serious hemorrhage, unless of pulmonary origin, in laryngeal tuberculosis is extremely rare, and sudden stenosis from edema or swelling equally so.

Treatment.—The fact must be recognized that in most cases the laryngeal lesion is simply one phenomenon in a constitutional disease. We are called upon to treat, however, not only the general condition but certain local lesions which interfere with the patient's comfort and tend to shorten his life. A prominent subjective symptom is the persistent cough. The neurotic element is, in some cases, very marked and is overcome in a measure by the use of sedatives, such as the bromide of potassium or sodium given in full doses, or small doses frequently repeated. It is important to protect the patient from irritating atmospheres as far as possible, to keep him in a uniform temperature, and to insist upon rest of the larynx and, when dysphagia is present, to provide nutriment easily swallowed and highly concentrated. It is found that large mouthfuls of food or drink are swallowed with less discomfort than small quantities. When odynphagia is very marked what is known as Wolfenden's method of feeding is resorted to with success. The patient is directed to lie prone upon the face with his head over the end of a lounge and is given nourishment in fluid form through a tube. Some patients who can swallow absolutely nothing without pain in the ordinary position are able to do so with ease when in this attitude. Hovell recommends a simple and but little known method of relieving pain in swallowing by means of firm pressure with the hands of one standing behind the patient. The pressure should be applied parallel with the posterior border of the ramus of the lower jaw, the fingers being directed upward, and gives greater relief the more firmly it is exerted.

There is difference of opinion about the effect of altitude in laryngeal tuberculosis. It is very certain that some patients do well, while others do not thrive, at high altitudes. As a rule, if heart complications or weakness exist, and in acute tuberculosis, it is

best to keep the patient near the sea level. It has been observed that tuberculous cases giving a history of long-standing antecedent catarrh which has advanced to atrophy do badly at high altitudes.

The usual general medication of supportive character is to be adopted. Cod-liver oil, hypophosphites alone or combined with oil, and in some cases the glycerophosphates of lime or soda are useful. Shurly warmly advocates iodine internally. He claims the best results when it is combined with some proteid, and is accustomed to give it in bouillon or milk. Arsenic, creosote, guaiacol and many other drugs are employed with possible benefit. Tuberculin except as a diagnostic test, has been generally abandoned doubtless in consequence of its improper use. Its revival in much reduced doses is now being urged. It is impossible in a limited space to review all the internal remedies recommended at various times, and were all to be enumerated we should still be forced to the conclusion that at present a cure for tuberculosis does not exist. Our chief reliance in restricting and suppressing the disease must be upon a more faithful observance of hygienic laws in general and more stringent precautions as to those already infected.

Fatty foods if assimilated seem to be of service. An excellent and somewhat palatable preparation of "mixed fats" (Russell emulsion) is generally well borne. Careful nutrition is important. Tuberculous patients should be encouraged to eat rather more than they seem to desire. The appetite may be stimulated with bitter tonics or alcohol in moderation and well diluted. The present tendency is to discountenance the use of alcohol in any form, the position being taken by many that it actually favors the development of tuberculosis. Yet at least in the later stages the comfort it gives should not be denied. A life in the open air and sunshine should be urged. Avoidance of bodily fatigue and mental worry must be ensured as far as possible.

The local treatment of tuberculous laryngitis is in some degree encouraging. Soothing inhalations, such as compound tincture of benzoin, oil of pine, eucalyptus and menthol are indicated. They reduce hyperemia and irritation; and they correct a tendency to the formation of viscid secretions in the cavity of the larynx, the expulsion of which is accomplished with difficulty. Continuous local medication by means of persistent use of a perforated zinc inhaler charged with equal parts of creosote, alcohol and chloroform

is strongly urged by Beverley Robinson. The most gratifying results are found in connection with the use of menthol. Whatever view may be held in regard to its antiseptic properties there is no question that it reduces congestion of the mucosa and renders the secretions more fluid and less tenacious. It may be applied directly to the diseased surface drop by drop with a laryngeal syringe in 15 to 20 per cent. solution. At first it is quite pungent and even painful without cocaine, but in a few moments a cool soothing sensation supervenes which is rather agreeable to most people. Menthol is soluble in olive oil or fluid albolene and is used in the larynx either hot or at ordinary temperature, whichever seems more grateful to the patient. Weak solutions used in a nebulizer at short intervals keep up a continuous effect and give as good results as those of greater strength.

The use of iodoform, either by insufflation or in ethereal solution, or in oily emulsion has been much in vogue and still is highly recommended. It is more or less valuable in the ulcerative stage combined with morphine and an astringent, as follows: morphine, 10 gr., tannic acid, 2 dr., iodoform, 6 dr. (Bosworth). This may be insufflated daily, care being taken not to use an excessive amount of the powder. One of the most promising substitutes for iodoform is *formidine* (methylen disalicylic acid iodide). It occurs as an impalpable, odorless powder, without staining qualities and possessing marked adhesive power of special value in the larynx. At times it causes some degree of pain owing to its liberation of formic aldehyde. Formalin as a pigment in 1 to 10 per cent. solution is highly recommended by Lake, either alone, or preferably combined with lactic acid according to the following formula. Formalin, 7 per cent.; lactic acid, 50 per cent.; glycerine, 20 per cent.; and water to 100 per cent. It is important to use a fresh preparation as the solution loses its strength in a week or two. Formalin is also used in powder as presented under the name *paraform*. In efficient strength the applications are quite painful although the pain is not very lasting. Better results, as regards relief from pain and coughing, follow the use of orthoform, mixed with an equal quantity of powdered gum acacia or subnitrate of bismuth. It acts only on an ulcerated or abraded surface. The parts having been gently cleansed with a detergent are sprayed with a 2 per cent. solution of cocaine, eucaine, or alypin. Thus the surfaces are benumbed and the powder is

not rejected by the act of coughing. The remarkable effects of insufflations of resorcin in promoting the repair of ulceration have been affirmed by McCall and others. It is best applied every other day mixed with orthoform in the proportion of one or two parts in three. These measures are almost certain to allay pain, and if resorted to shortly before food is to be given the nutrition of the patient may be sustained much more effectively than would otherwise be practicable. If they fail to arrest the cough we shall be compelled to have recourse to opium or one of its alkaloids, heroin, codein, or morphine. In irritable pharynges and especially in the hyperemic form of tuberculosis excellent results have been observed from spraying the larynx with a suprarenal extract solution containing 1 grain of phenic acid to each drachm. In these cases it is important to use only a straight spray, the patient being taught to inhale at the moment. With a down spray there is danger of provoking spasm of the larynx and a violent paroxysm of coughing. Long curved tubes intended for insertion into the cavity of the larynx itself are quite unnecessary.

The modern method of treating tuberculous laryngitis, by no means universally accepted, is based upon surgical principles as applied to deposits in other regions. An attempt is made to remove the diseased tissues by curetting, or excision, and to convert the tuberculous lesion into a healthy granulating ulcer by destruction of the morbid structures with a corrosive acid, preferably lactic acid. Many years ago the practice of puncturing the edematous and infiltrated tissues was proposed by Marcet. The painful tension often present in these tumefactions is thus relieved. According to Moritz Schmidt the swelling subsides and in addition beginning ulcerations heal. The fear once entertained of infection and ulceration of the wounds thus made is not supported by clinical experience. On the contrary repair takes place and relief of odynphagia is often complete. In this connection it should be noticed that spontaneous repair of tuberculous ulcers in the larynx has several times been observed. Tuberculous subjects, moreover, almost invariably improve temporarily under any new system of treatment and it is difficult at first to determine how much potency should be ascribed to a new drug or application. Much-vaunted specifics prove after extended trial to be inert. One after another they have to be abandoned and the search for an antidote must be

renewed. Hence we turn with hope to surgery, believing that although the disease itself may not be cured, prolonged suffering and a distressing death from ulcerative tuberculous laryngitis may be thereby averted.

The details of treatment of a tuberculous larynx by curetting are described as follows. In the first place the patient may have to be put through a course of training in order to overcome the intolerance of the passages. It is impossible to perform any manipulations in the larynx satisfactorily unless the parts are under control. Usually,

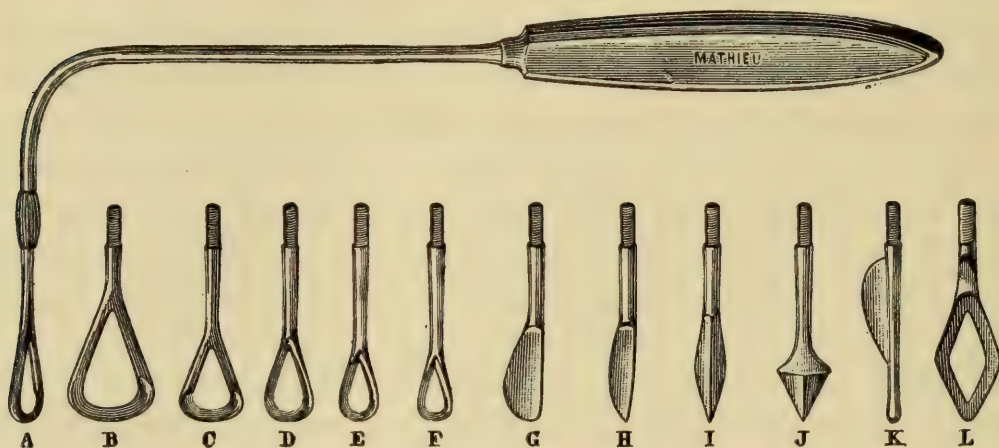


FIG. 135.—Heryng's Laryngeal Curettes and Scarifiers.

even if they are very irritable, sufficient tolerance is established by a preliminary spraying of the larynx and fauces with a 10 per cent. solution of cocaine. In curetting the larynx the field of operation is often obscured by the effusion of blood. This source of difficulty is in a measure obviated by the use of suprarenal extract in combination with cocaine. The ideal case for surgical treatment is one in which the tuberculous infiltration is situated at the posterior wall of the larynx, either in the region of the arytenoids or at the posterior commissure. Deposits in other situations are less accessible but still if not too extensive they may be amenable to this mode of treatment. The parts having been prepared a laryngeal curette, of the model of Krause or Heryng (Fig. 135), is passed into the larynx under the guidance of the mirror and the affected surfaces are thoroughly and boldly scraped until we are reasonably sure that the tuberculous deposit has been completely removed, or has been sufficiently exposed. And here is the main difficulty. It is impossible to tell positively when the limits of the dis-

ease have been reached. We are compelled to rely upon a judgment authorized by careful study of the parts beforehand.

After bleeding has subsided we are ready for the application of the acid. The laryngeal applicator, wound at the end firmly with a small pledget of cotton and moistened with a solution of the acid, is passed into the larynx, the mirror showing the way as with the curette. It is not enough simply to touch the abraded surface; the acid must be thoroughly rubbed in. The help of the patient is needed, and he should be taught to hold the tongue firmly between the folds of a napkin with the thumb and forefinger of the right hand. Lactic acid is said to have an affinity for morbid tissue and does not act upon healthy mucous membrane. While this statement may be true we should never begin treatment with the full strength of the acid, and care should be taken to avoid using an excessive quantity. It is best at first to use not stronger than a 20 per cent. solution, until we know what degree of reaction may be excited and how well the pain of the application may be endured, gradually increasing to full strength, if the patient is courageous and the parts not too sensitive.

When the effect of the cocaine has worn off there is always more or less discomfort, and usually actual pain, which may last several hours. After the lapse of a week the process of rubbing in the acid is repeated with increased strength. The number of applications depends upon the situation and extent of the lesion and upon the effects. Usually we see, after the second or third application, an effort at repair of the ulcerated surface. It is well to suspend interference for a week or two, or until signs of arrest of the reparative process, or of the development of new foci are evident. Cicatrization goes on with more or less rapidity until, in the course of two or three months, complete repair is attained. Unfortunately, however, the cicatrices show a tendency to break down, either because of the failure of complete extirpation of the disease, or of inherent weakness in the tissues.

The use of lactic acid following curettage has many opponents, both because of the excessive pain incident to the treatment and for the more important reason that results are not uniformly satisfactory. Better results with practically no discomfort to the patient are claimed by Freudenthal for an elaboration of the menthol treatment proposed years ago by Rosenberg. The details are as follows. The larynx

is first thoroughly cleansed with some detergent solution, after which the parts are insufflated with three to six grains of powdered saccharated suprarenal gland. Cocaine has been discarded because of the paresthesia it causes in many patients, for the reason that it often affects the heart unfavorably, and finally on account of the fact that its solution is prone to decompose. These objections do not apply to powdered adrenal. After a few minutes an emulsion of menthol-orthoform made by the following formula is *slowly* instilled with a laryngeal syringe.

R.

Menthol	1-15
Ol. amygdal. dulc.	30
Vitelli ovorum	25
Orthoformi.....	12.5
Aquæ destell. q. s. ad	100

Ft. emulsio.

The relief from pain lasts several hours or even days, so that a patient is able to take nourishment with ease. Under this method it is claimed that infiltrations disappear and ulcerations heal, and it apparently has no objectionable features.

In the absence of ulceration excision of tuberculous masses may be effected with a double curette or punch forceps. Applications or injections of cocaine permit this to be done without extreme pain. It is only suited to cases of very circumscribed disease. Indeed radical interference of any kind should be reserved for limited ulcerations and infiltrations within easy reach, for primary laryngeal disease and for cases in which pulmonary disease is circumscribed, incipient, and quiescent. The principles governing the question as laid down by Heryng are believed to be logical. In brief he regards cases of advanced pulmonary disease attended by hectic and emaciation, diffuse miliary tuberculosis and extreme inflammatory stenosis of the larynx as decidedly inappropriate for operation. In addition it is contraindicated in neurotic and timorous patients in bad general condition. When the epiglottis alone is involved removal of this appendage through the mouth is feasible and entails no special inconvenience. Such cases have been reported by Solis-Cohen and Hajek, and R. Lake mentions having three times removed the larger part of the epiglottis with the galvanocautery snare without pain and with good effect. Ulceration in this situation is often very distress-

ing, yet a patient under my observation has lost nearly one-third of his epiglottis and has never had a particle of pain. Attention has been called by Lake to the occurrence of postoperative pyrexia as a positive indication for discontinuing operative interference.

In line with this mode of attacking tuberculosis of the larynx it may be mentioned that thyrotomy has several times been resorted to and that laryngectomy has been done fifteen times for actual or supposed tuberculosis, eight total and seven partial operations (Gleitsmann). It is hard to conceive that any circumstances would justify these procedures. On the theory that rest of the larynx is essential to secure repair of laryngeal ulcerations tracheotomy was practised for several years. My experience with it leads me to believe that it merely adds one more source of discomfort without commensurate advantage. When the condition has become so serious that feeding by enemata or with an esophageal tube must be considered the time for active treatment of any kind is past and palliation is our last resource.

The influence of the chemical rays of light upon morbid processes has long been appreciated, and the subject has been recently taken up with renewed interest. In ancient times sun and air were considered essentials to health and life, and all the customs of the people were based on this idea. Electric light produces effects upon the system similar to those of sunlight, and modern phototherapy is the direct outcome of the old theory of light as a therapeutic agent. The conclusions reached by Sörgo and Kunwald are decidedly favorable. The former uses a rather elaborate system of mirrors, the latter the ordinary laryngoscope for reflecting the sunlight. Jessen, whose experiments have been made at a high altitude (Davos) is somewhat less enthusiastic and makes the pertinent suggestion that the good results are in part due to abstention from harsh and irritating measures while the solar treatment is being conducted. The power of sunlight at least to retard the growth of tubercle bacilli in culture tubes seems to have been demonstrated. The stimulus of light to the function of ciliated epithelium expedites chemical changes, or in other words oxidation, which result in activity. Thus the rays of light do double duty in destroying germs and in exciting movements of cilia which serve to clear out secretions and irritating particles from the upper air-track. Especial attention has been given to this matter by Freudenthal, who has experimented with the arc light and

the incandescent light in tuberculosis of the lungs as well as of the larynx. In cases of tuberculous ulceration and infiltration of the larynx the subjective symptoms were relieved and a definite cure of the laryngeal lesion was observed. This method, which is certainly free from disagreeable features, is deserving of further trial. In this connection the observations of Wolfenden and Ross as to the therapeutic effect of the X-rays are of interest, their conclusion being that the rays stimulate rather than check the growth of bacilli.

Submucous and intratracheal injections of various substances, as advocated by Watson Williams, Chappell, Donellan and others, have not been widely adopted. Creosote, guaiacol, 20 per cent., lactic acid, and biniodide of mercury, 1 to 1,000, seem to be efficacious in some cases. The galvanocautery is used by a limited number, but is generally regarded as more or less dangerous. Williams in particular advises the galvanocautery point in the subglottic region for flat diffuse infiltrations which cannot be easily reached with forceps. In the experience of some it has never caused an acute edema of the glottis or violent reaction of any kind, and it is especially recommended by Gouguenheim and Tissier for fungous vegetations, or "pseudo-polypoid" formations.

Electric cataphoresis, whereby the tissues are saturated with a medicament antagonistic to the morbid germ and stimulant to healthy repair, deserves more attention than it appears to have received. Guaiacol and oxychloride of copper have given the most satisfaction. Spherical electrodes of pure copper are preferred to needles for use in the larynx, since the former make no lesion of the mucous membrane. A weak galvanic current with the positive pole connected with the laryngeal electrode and the negative applied to the nape of the neck, is used every other day, the interval and the duration of the sittings being regulated by the strength of the patient and the results. Some throats are so irritable that this method is not feasible even with cocaine anesthesia. The following advantages are claimed for cupric electrolysis (Scheppegegrell). (1) There is no destruction of tissue, or lesion of the surface through which pathogenic germs may reinfect the system. (2) There is no reaction nor hemorrhage. (3) It requires no extraordinary skill, and is especially easy when direct laryngoscopy (Kirstein) can be used. (4) It is applicable to all cases of laryngeal tuberculosis.

Percutaneous galvanism and faradization have been used in tuber-

culosis of the larynx to a limited extent with apparently definite and favorable results, but no final conclusion regarding them has been reached.

It is somewhat the custom to pronounce the doom of an individual discovered to have tuberculosis and to content ourselves with efforts to ease his steps to the grave. Experience teaches that this desperate view should not be entertained. Although a large proportion of cases are inevitably fatal, yet we should not sit inactive and permit the ravages of the disease to go on unresisted. It is rather our duty, without relaxing the search for a remedial agent, to teach that hygienic living, pure air, and good food furnish the most effective weapons against the approach of the subtle enemy. As indispensable adjuvants we should insist upon voice rest, the avoidance of local irritants of every kind, the adoption of a diverting occupation, and abstention from overexertion and physical fatigue. All of these conditions, which render home treatment possible and most desirable, are at the command of only the well-to-do. Segregation of those less fortunate in hospitals and sanatoria should be under the strictest surveillance. Although tuberculous subjects are as a rule sanguine and cheerful, yet upon certain temperaments the depressing effect of intimate association with other invalids is quite detrimental.

Suitable cases for surgical treatment are few; cures in the proper sense of the word are fewer still; but even from the most conservative standpoint, except in extreme cases, we have within reach the means which enable us to assure amelioration of symptoms and prolongation of life. Obviously when called upon to treat a case of laryngeal tuberculosis we are brought face to face with a complex problem to be viewed from many sides. We may at least refrain from inflicting additional torture upon the sufferer by useless and possibly harmful local meddling.

CHAPTER XXII.

SYPHILIS OF THE LARYNX.

The lesions of *hereditary* syphilis in the larynx are somewhat rare. It is admitted that a syphilitic dyscrasia is responsible for many derangements of the air-tract in the new-born, but that pathological phenomena characteristic of syphilis are as frequent in hereditary as in the acquired disease is by no means established. On the other hand J. N. Mackenzie believes that laryngeal lesions in congenital syphilis are not infrequent, and are simply not found because not sought. Two cases have been reported by Monti of syphilitic development in the larynx in intra-uterine life. A division into secondary and tertiary is not practicable, the first manifestations of hereditary syphilis often being deep destructive ulcerations. Usually the laryngeal lesions are associated with or follow characteristic affections of the eye, malformations of the teeth, or other phenomena distinctive of syphilis. Two-thirds of the cases occur in the first year of life. Alteration of the voice and of the cry of the child, the occurrence of cough, dyspnea and attacks of laryngismus are commonly observed. Laryngoscopy is difficult but by no means impossible in the early years of life. Kirstein's mode of examining the larynx is feasible when the ordinary methods fail.

The best treatment of hereditary syphilis of the larynx consists of inunctions with mercurial ointment or the internal administration of gray powder. Some cases do better when mercury is combined with the iodides or hydriodic acid, or with general tonics.

Locally, mentholized or borated albolene in vapor or spray has a beneficial effect. The question often arises whether in the presence of active hereditary disease, enlarged tonsils and adenoids should be removed. The coexistence of a syphilitic taint should certainly not be regarded as a contraindication, if it is evident that these hypertrophies are making an impression upon the general health. Intralaryngeal infiltration or distortion from cicatricial contraction may so impair the lumen of the child's larynx as to suggest the necessity of tracheotomy or intubation. The latter mode of re-

lieving the stenosis is preferable unless an excessive amount of cicatricial tissue be present. If the obstruction of the larynx has come on rather *gradually* it is probably due to cicatrices and, whether in children or adults, we are confronted by a most serious complication which is capable of relief only after a very tedious and rather unsatisfactory course of treatment. Internal medication cannot be expected to make any impression on adventitious bands of scar tissue, and we are forced to choose between the introduction of a trachea tube, an intubation, and division with dilatation of the stricture. A tracheotomy may be required as a preliminary to attempts to overcome the stenosis by the use of bougies. Months and even years may be spent in the process of stretching a syphilitic stricture of the larynx and after all the result may not be permanent. In any case the phonatory function of the larynx will have been impaired or lost. Experience with the O'Dwyer tube of vulcanite or metal is quite encouraging. The metal tube has a proportionately larger lumen and its weight tends to keep it in place. In one of O'Dwyer's cases the tube was worn upward of a year. In exhaustive reports on this subject by Lefferts and by W. K. Simpson abundant evidence appears of the value of intubation in these cases and of the ease with which the tube is tolerated for a very long period. In view of the tardy and often disappointing results from this method partial resection of the larynx has been advocated by certain authorities. Schroetter, a most enthusiastic partisan of systematic dilatation after tracheotomy, has had several successful cases with the use of tubes of gradually increasing diameter, and similar success has been achieved by others (Fig. 136). Dilatation from below through a trachea tube has been recommended by Stoerk and is preferable in some cases. Rapid stretching of a syphilitic stricture is almost invariably followed by excessive inflammatory reaction and should never be employed. The "dilating laryngotome" of Whistler, an almond-shaped dilator in which is concealed a knife blade to be protruded by a lever in the handle of the instrument, seems to have given excellent satisfaction in many cases. It has been modified by Lennox Browne by making the shaft of the instrument hollow and thus the operator is enabled to make the incisions with more deliberation and certainty without fear of completely obstructing the air-tract. The results of treatment are much more gratifying and permanent in the larynx, as elsewhere, provided the bands of scar tissue

are thin and not very numerous. In many cases, especially if the stenosis involves the trachea as well as the larynx, the only resource is a trachea tube to be inserted as low as possible and permanently retained. Stenosis of the larynx developing somewhat *rapidly* is generally caused by edema or by gummatous infiltration. The marvellous and prompt relief given in these cases by internal medication, even when a tracheotomy seems unavoidable, has been insisted upon by Krishaber and others. A boy, ten years of age, was once brought into my clinic cyanotic and gasping for breath. There was no

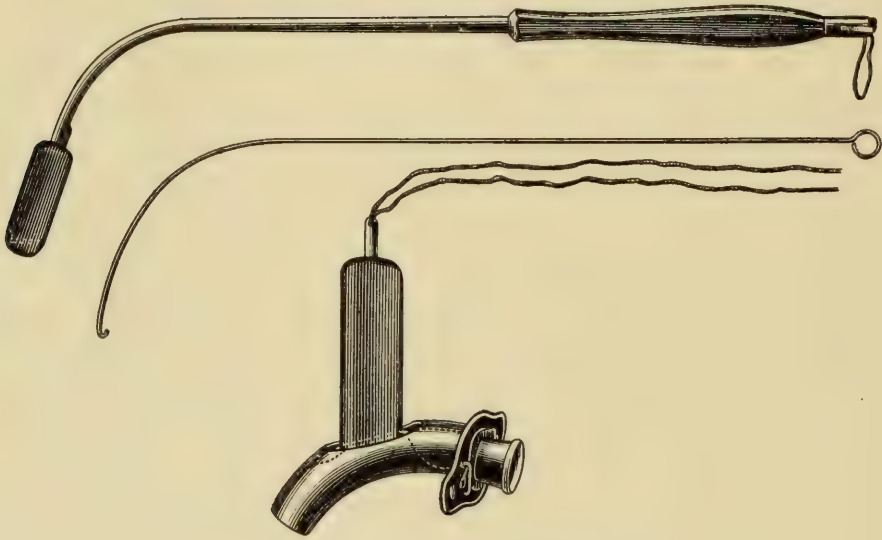


FIG. 136.—Schroetter's Laryngeal Dilator.

The metal plug is attached to the introducer by a twine which is drawn through the hollow handle by means of the slender flexible hook. The plug fits into the fenestra of the trachea tube and is held in place by the inner tube the upper part of which is prolonged as a solid rod.

time to ask questions, so I at once opened the trachea. The history of the case afterward obtained proved clearly that the boy was a victim of hereditary syphilis. The usual treatment was followed in a few days by subsidence of the laryngeal stenosis so that it was possible to remove the trachea tube. The laryngoscope showed extreme deformity of the larynx from old ulceration and cicatricial bands, but the breathing space was ample and very likely might have been rendered so by internal medication alone without the aid of a tracheotomy.

The lesions of *acquired* syphilis of the larynx are limited to those of the so-called secondary and tertiary periods. Wide discrepancies

exist among authorities as to the frequency of its occurrence, one observer having met with it in only 2.9 per cent. (Lewin) of all laryngeal cases observed; another found it in 34 per cent. (Sommerbrodt).

Predisposing causes of syphilis of the larynx in the acquired disease are catarrhal conditions, neglect of treatment in the early stages, and bad hygiene such as often prevails among the poorer classes. Primary syphilis has not been met with in the laryngeal cavity. A case of chancre of the epiglottis reported by Moure is unique.



FIG. 137.—Early Secondary Lesions of Vocal Bands. (*Schnitzler.*)

Secondary lesions generally coexist with a cutaneous eruption, or closely follow it. An erythema of the larynx is very apt to accompany a similar condition in the fauces, and differs but little from a simple erythema except that the redness of the former is less intense and less diffuse, the membrane having a mottled appearance. It causes no symptoms of importance except more or less hoarseness, and requires no very energetic local treatment (Fig. 137).

The occurrence of mucous patches in the larynx has been denied by many excellent observers, but numerous authentic cases are now on record. When present on the epiglottis they often appear as condylomata or warty excrescences. These lesions are seldom symmetrical. They disappear under treatment or spontaneously but are prone to recur. They are often found associated with gen-

eral erythema which involves the pharynx as well. They may be single or multiple and in the mirror present the appearances characteristic of mucous patches in other regions, namely, elevated erosions with a surface of a peculiar grayish hue and surrounded by a more or less pronounced areola of redness. It is quite probable that mucous patches in the larynx often fail to attract attention on account of the slight functional disturbance they excite, and of the greater importance of coincident symptoms.

The form of superficial ulceration named by Whistler "relapsing ulcerative laryngitis" possibly begins as a mucous patch. The voice is generally husky and rauous. The singing voice is absolutely abolished and the probability of its recovery is very doubtful. Respiration is wheezy. There is more or less irritating cough without an excessive amount of expectoration. There is seldom any pain. In examining the larynx with a mirror we find instead of a uniform redness of the mucosa a mottled hyperemia, and erosive patches are seen on the ventricular bands, upon the free edge of the epiglottis, on the arytenoids, or at the posterior commissure. Gottstein describes them as "round or elongated grayish-white spots of thickened epithelium, slightly raised above the congested tissue which surrounds them, and either sharply circumscribed or shading off into the congested mucous membrane." Ordinarily, there is no very obvious change in the texture and conformation of the mucous lining of the larynx except in the existence of diffuse condylomata. Occasionally the edges of the vocal bands are eroded or notched and adhering to them are seen masses of viscid secretion. Usually confirmatory symptoms elsewhere in the body are present. A cutaneous eruption, posterior cervical or epitrochlear lymphadenitis, or some of the other well-known symptoms of secondary syphilis, establish the diagnosis. The impairment of general health is no more than might be reasonably expected from the systemic disturbance unless the laryngeal lesions are so aggravated as to interfere with rest at night, or with comfort by day (Fig. 138).

The so-called *tertiary* lesions of acquired syphilis are of much more serious importance. They begin in the deeper tissues or reach them by extension from the surface of the mucous membrane. They occur as gummatous tumors or infiltration and as ulcerations superficial or deep, resulting from disintegration of gummatous infil-

tration. The latter present the form of circular or crescentic ulcers, with sharp elevated edges, sometimes undermined, surrounded by an inflamed areola. The color of the mucous membrane is somewhat less red than in simple inflammations. The resultant deformity varies with the degree of infiltration, the loss of tissue, or the disposition and extent of cicatricial formations. The effect upon the voice depends entirely upon the site of the lesion, whether upon the vocal bands themselves or at some point where the action of the intrinsic muscles of the larynx is only slightly interfered with. Dyspnea may



FIG. 138.—Superficial Lesions of Vocal Bands in Early Syphilis
(*Schnitzler.*)

be due to infiltration, cicatricial contraction, edema, or ankylosis of the cricoarytenoid joint. More or less cough is usually present, and the expectoration is sometimes streaked with blood when an active ulcerative process is present. Deglutition may be impaired and painful if an ulcer involves the margin of the glottis. There may be no cachexia or impression upon the general health unless swallowing is interfered with (Fig. 139).

In all therapeutics there is no more satisfactory and definite result of treatment than in the disappearance of a gummy tumor under the influence of iodide of potash, provided the stage of softening has not been reached. It is a remarkable fact that one of these tumors may remain quiescent for months or even years and then from some inexplicable cause begin to break down and ulcerate. A gummatous infiltration may be diffuse or in the form of circumscribed tumor, single or multiple. Dyspnea is proportionate to the degree of en-

croachment on the respiratory track and interference with phonation varies with the relation of the lesion to the vocal bands. There is always danger of an access of inflammation or edema which may cause a dangerous stenosis. There is seldom much pain unless the rim of the glottis is involved in ulceration, or the perichondrium and the cartilages become affected. Necrosis or caries of the cartilage may take place. A fragment of dead cartilage may be extruded in the act of coughing, or may become embedded in a dense mass of cicatricial tissue. Usually a gummy tumor develops rather rapidly and presents as a symmetrical painless tumefaction covered by normal mucous membrane. It is impossible in the absence of a positive

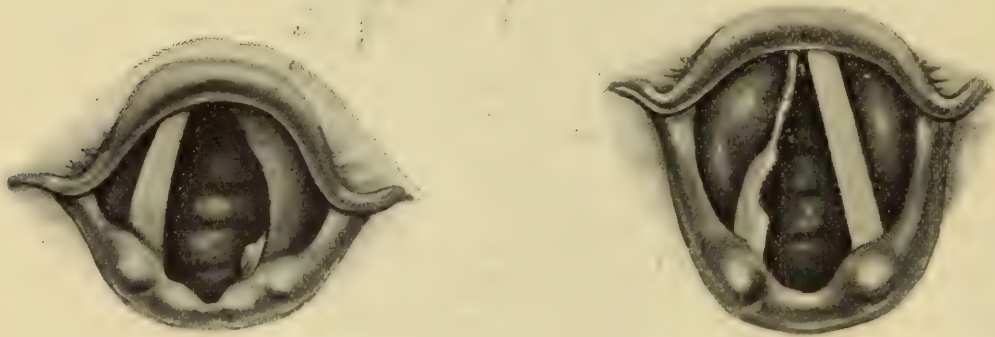


FIG. 139.—Destruction of Vocal Bands by Late Syphilitic Ulceration.
(Schnitzler.)

specific history, to differentiate the condition from a malignant neoplasm without resort to a test with antisiphilitic treatment. The importance of recognizing a gummy tumor before the process of disintegration has begun must be obvious. When ulceration is established we have to look forward to the deformity from distorting scars which always follows repair of a syphilitic ulcer.

The *prognosis* in tertiary syphilis should be guarded. The patient is in danger from edema implanted upon a more or less extensive infiltration, or from hemorrhage due to invasion of a blood-vessel by an ulcerative process.

The *treatment* should be active and in accordance with the method of treating syphilis in general. In secondary laryngeal lesions mercurials are indicated and, locally, the condition should be handled by soothing or stimulating inhalations as in simple chronic laryngitis. Nitrate of silver, unless ulcerations are present, is best avoided from its tendency to promote hyperplasia. In the deeper tertiary lesions

the iodides in rapidly increasing doses, combined with cod-liver oil and general tonics, and alternating with mercurial inunctions, or injections or used together with them, give the best results. In the tertiary ulcers, nitrate of silver in strong solutions, or fused on a probe, and even the galvanocautery, may be required to stimulate healthy reparative action. Stenosis due to infiltration usually yields to saturation of the system with iodides. The management of that resulting from cicatricial contraction has been described.

CHAPTER XXIII.

NEUROSES OF THE LARYNX. HYPERESTHESIA. ANESTHESIA. PARESTHESIA. NEURALGIA. HYSTERICAL APHONIA. LARYNGEAL VERTIGO. CHOREA. SPASM OF THE LARYNX. LARYNGEAL STRIDOR AND WHISTLING. PARALYSIS OF THE LARYNX.

SENSORY NEUROSES. HYPERESTHESIA OF THE LARYNX.

Hyperesthesia, or excessive sensitiveness of the larynx, is usually symptomatic of some inflammatory condition, and is especially noted in phthisis and in carcinoma. The degree of normal sensitiveness differs greatly in different individuals and is apt to be more marked in those of nervous temperament. It is exaggerated in alcoholics, while, in syphilis, it is usually diminished. In conjunction with abnormal pallor of the mucous membrane it must be regarded as of rather serious import in relation to the probable development of tuberculosis.

ANESTHESIA OF THE LARYNX.

Anesthesia of the larynx may result from some lesion involving the trunk of the superior laryngeal nerve. It is frequently marked in central nervous troubles, in hysteria, and as a sequel of diphtheria. In some cases of chronic laryngitis there is diminution in the sensitiveness of the laryngeal mucosa. In anesthesia of central or bulbar origin nothing can be effected by treatment. In other cases the use of nerve tonics is indicated, and faradism is of service, the internal electrode being placed in the sinus pyriformis in order to bring it as near as possible to the superior laryngeal nerve (Ziemssen). If the lesion is bilateral there is danger from the entrance of food or foreign bodies into the air passages.

PARESTHESIA OF THE LARYNX.

Paresthesia, or perverted sensation, of the larynx, includes burning, tickling, a sensation of a foreign body, a constant desire to swallow, and a simple feeling of irritation. It may be associated with some organic structural lesion, or the consequence of lymphoid hypertrophy at the base of the tongue. It may occur as a reflex phenomenon from disease in some remote region, or it may be merely a symptom of neurasthenia or hysteria. The tickling sensation is very annoying, and occurring in the course of certain tuberculous lesions of the larynx and in neurotic subject, is provocative of distressing cough.

NEURALGIA OF THE LARYNX.

Neuralgia of the larynx is said to occur in the course of rheumatism and gout and in malaria. Pain is a prominent symptom in cancer and phthisis and in connection with some acute inflammatory troubles, but genuine functional neuralgia of the larynx is believed to be a rare occurrence. Associated with spontaneous pain there may be tenderness on pressure over the larynx externally, especially in the vicinity of the greater cornu of the hyoid. There is no abnormal appearance to be seen in the laryngeal mirror. Reported cases, like that of Schnitzler, in which the pain was so intense that the patient was on the verge of suicide, and which was cured by brushing the larynx with a solution of chloroform and morphine, and like that of Bosworth, in which tracheotomy was contemplated for the relief of a sense of suffocation and in which a cure was effected by aconitia pushed to its physiological effect, would suggest that the condition must be regarded as, in large part, hysterical. In all probability, any pronounced impression would have induced a cure. Such cases are amenable to hypnotic suggestion. Most of these sensory neuroses occur in neurotic subjects and in those in impaired general health. The indications then are clearly for the use of general tonics and good hygiene, combined with mental diversion. The galvanic current, the positive pole in the larynx, has been found beneficial.

MOTOR NEUROSES. HYSTERICAL APHONIA.

An interesting functional neurosis not infrequently met with in females, hysterical aphonia, is characterized by complete loss of voice without any gross lesion of the larynx. Phonatory movements of the larynx are symmetrical but incomplete; the cords fail to approximate in attempts at phonation, or at once retreat after momentary adduction, and the patient merely succeeds in producing a whisper. The loss of voice is as complete as in inflammatory conditions, but while the laryngeal picture in the latter is abnormal, in hysterical aphonia there is no deviation from health. The ability to cough is retained, this condition thus differing from a genuine paralysis, and under general anesthesia phonatory power is restored. There is rarely any interference with breathing, a single case having been



FIG. 140.—Hysterical Paralysis of Adductors. (*Schnitzler.*)

reported by Meschede in which the affection simulated bilateral abductor paralysis, and the necessity of opening the trachea was being considered, when the voice was suddenly recovered and the dyspnea ceased. The loss of voice and its recovery are generally equally abrupt. The occurrence of sudden shock or extreme excitement acts as a stimulant to phonation or, if any doubt remains as to the character of the trouble, the administration of an anesthetic will clear it up. Not infrequently hysterical aphonia is of reflex character dependent upon uterine disease, or upon some lesion in the nasal chambers or the naso-pharynx (Fig. 140).

LARYNGEAL VERTIGO.

Laryngeal vertigo, also called laryngeal apoplexy, laryngeal syncope and complete glottic spasm, is a rare condition usually preceded by a sensation of tickling or discomfort in the larynx and paroxysmal

cough. The patient grows dizzy, generally falls, becomes momentarily unconscious, and presently recovers without any subsequent ill effects. There are sometimes congestion of the face and slight convulsive movements which are not to be confounded with those of true epilepsy. The condition resembles the epileptiform seizures which occur in tabes. There is no laryngeal lesion discoverable. Charcot likens it to Ménière's disease and believes it is reflex in character. Nearly all the cases observed were in males past middle life. The attacks vary from a single one to as many as fifteen a day (Charcot). McBride believes they are due to forced expiratory efforts against a partially closed glottis which causes congestion as in prolonged paroxysmal cough and whooping-cough. F. I. Knight, who has made a careful study of this subject, corroborates the views of McBride in large part, but notes the fact that the presence of spasm of the glottis in most cases has not been proved, and he surmises that even in its absence the head symptoms and loss of consciousness may be readily explained by the disturbance of the cerebral circulation consequent upon rapid respiration.

The *prognosis* is good. There is seldom any serious complication and the correction of local disease or general disturbance is followed by disappearance of the laryngeal symptoms. In all cases careful examination should be made of the pharynx, base of the tongue and upper air-tract; not infrequently hyperemia or varix at the base of the tongue is discovered which is relieved by the use of the galvanocautery. Astringent applications to the pharynx and counter-irritation over the larynx have been recommended.

In some cases the bromides or other nerve sedatives, iron, ergot and salines are beneficial and careful attention should be paid to the diet and the condition of the digestive tract. Stimulants should be avoided.

CHOREA OF THE LARYNX.

Chorea of the larynx usually occurs in connection with some other neurotic symptom or with general chorea. Almost invariably a local lesion like an elongated uvula, hypertrophy of the glands at the base of the tongue, or enlarged tonsils coexists as an exciting cause. The most conspicuous symptom is a dry explosive cough at short intervals through the day only. The voice is not affected, although

phonation may be somewhat jerky. It is usually met with in girls approaching maturity, although one case has been observed at the age of forty-two (F. I. Knight). Gottstein believes that many of these cases are examples of so-called "nervous cough" rather than a genuine chorea, but so many cases have been reported by such careful observers as Lefferts, Roe and others that there can be no doubt as to the occasional occurrence of true choreic spasm of the glottis. The best results in treatment have followed the adoption of good hygiene, the use of electricity, bromide of potassium internally, or Fowler's solution in physiological doses. In all cases nasal stenosis should be corrected, and the abnormalities above referred to must be removed.

SPASTIC APHONIA.

Spastic aphonia, or dysphonia, is the name given to a condition of adductor spasm occurring on attempts at phonation and ceasing when the effort to speak is discontinued. It has been observed only in adults and generally in females. It is apt to follow overuse of the voice and has been compared by Schnitzler to "writer's cramp." In some cases the cartilaginous portion of the glottis remains open, in others the adduction is so forcible that the vocal bands actually overlap and stenosis is complete. In some the spasmodic movements are irregular, or clonic, producing what has been called by James "stammering of the vocal cords." At times the attacks increase in frequency and severity and are finally excited by other causes than the attempt to speak. Distinct pain or a feeling of cramp in the region of the larynx is sometimes present.

SPASM OF THE LARYNX IN CHILDREN. LARYNGISMUS STRIDULUS.

Spasm of the larynx, or paroxysmal closure of the glottis, may be caused by some irritation of the recurrent laryngeal nerve, or of the trunk of the vagus, or may be of purely reflex origin, as from adenoids, difficult dentition or intestinal parasites. In children it is most common in the first two years of life and may be produced by very slight causes. It is more frequent in male children and in the winter months. Ill-nourished rachitic children are especially prone to

laryngismus. In these cases also glandular enlargements, particularly affections of the bronchial glands, and diseases of the nervous system, notably hydrocephalus, are named as etiological factors. In children of highly nervous temperament a catarrhal inflammation of the larynx, or of the air-tract generally, gastric or intestinal irritation, or any profound emotion may induce an attack. Usually there are no premonitory symptoms. The child goes to sleep at night in usual health, is suddenly wakened and after giving two or more short crowing inspirations ceases to breathe. After a few seconds and several long noisy inspirations normal respiration is resumed. Such attacks are repeated at short intervals and interfere but little with health or comfort except at the time. In more severe cases the muscles of the extremities are involved and general tonic convulsions occur, with momentary loss of consciousness and irregular heart action. Attacks of this type are very terrifying as well as dangerous. In milder cases it is noticed that the paroxysms are more apt to come on at night and that the intervals between them are shorter.

The *prognosis* is generally good, the liability disappearing with improvement in nutrition and decrease of nervous irritability. Death occasionally occurs in weak children from asphyxia or general convulsions. A fatal result may also follow from pressure due to effusion in the ventricles of the brain. When the attacks are severe and frequent so that the general health begins to suffer the outlook is less favorable.

In the *treatment* of this condition it is important that attention be directed to the general health with a view of warding off the attacks. At the same time the paroxysm itself must be relieved if possible, although it is clear that many of the measures resorted to under these circumstances are utterly useless. Yet in the presence of relatives frantic with fear and of a child cyanotic and apparently dying from apnea we are obliged to do something. In severe cases swallowing is impossible and respiration is suspended so that we are debarred from the use of internal remedies and inhalations until the spasm subsides. Tight clothing should be loosened and a supply of fresh air furnished by opening the windows. Friction of the extremities and purgative enemata are indicated. Immersion in a hot bath with cold affusions to the head is useful. When the spasm does not yield catheterization of the larynx, intubation, or tracheotomy is called for. The first mentioned is recommended by Gottstein.

Artificial respiration and possibly stimulation of breathing by electricity may be of service. As a rule, the case terminates by relaxation of the spasm or asphyxia before these resources can be made available. In the intervals the diet must be carefully regulated as regards both quantity and quality of food. Gastrointestinal derangements must be corrected and excessive nervous irritability controlled by sedatives, especially bromide of potash. Antipyrine has been used successfully, and various antispasmodics are now and then resorted to. Rickets, struma, lymphadenitis, anemia and other constitutional disorders require appropriate treatment. The use of morphine would probably be considered inadvisable by most practitioners, yet Bosworth regards a sixteenth of a grain of morphine combined with one five-hundredth of atropine hypodermically as effective and quite safe in a child of eighteen months. Scarification of the gums should be done in impeded dentition, and feeding with a spoon instead of allowing the child to take the breast, when as occasionally happens the act of nursing seems to excite an attack, should be tried. In high-strung nervous children the avoidance of undue excitement is very important.

SPASM OF THE LARYNX IN ADULTS.

The occurrence of spasm of the larynx in adults is very rare. Among the most frequent causes may be mentioned hysteria and pressure upon the pneumogastric or inferior laryngeal nerve by a new growth or an aneurysmal tumor, the compression being sufficient merely to irritate the nerve trunk without completely impeding its function. In epilepsy, hydrophobia, tetanus, chorea and locomotor ataxia spasm of the glottis is not uncommon. It frequently follows a local application to the larynx, especially if much force be used or the character of the application be irritating. Foreign bodies are very apt to provoke a spasm; neoplasms are less likely to do so because in their process of slow development the parts become accustomed to their presence. Bosworth refers to cases cured by correction of a deviated septum, reduction of nasal hypertrophies and removal of nasal polypi, and mentions having seen "some very interesting cases of laryngeal spasm in the chronic pharyngitis of alcoholism." A unique and perhaps dubious case is that of Hack in which the spasm is supposed to have been induced by a hyperemic

condition of the mucous membrane of the pyriform sinus in which situation the superior laryngeal nerve is quite superficial. Except when occurring as a phenomenon of locomotor ataxia the seizures are generally nocturnal. They are very transient and seldom involve any danger to life except in tabes, although Heryng reports several cases of reflex spasm from intranasal disease in which tracheotomy was required. The treatment of the case otherwise depends upon the cause. Local lesions of the upper air-tract must be corrected and so-called nerve tonics and sedatives are indicated. Nearly all patients of this class are below par in general health and in a state of nervous erethism which predisposes them to all sorts of functional disturbances. Any modification of regime or habits which may contribute to improvement in these particulars must be enforced.

LARYNGEAL STRIDOR AND LARYNGEAL WHISTLING.

Two curious conditions are met with in young patients which may be mistaken for more serious lesions. The first, *aryngeal stridor*, appears in infants at or soon after birth, and is rarely accompanied by cyanosis and dyspnea. There is no aphonia. A difference of opinion exists as to its cause. It resembles ordinary laryngismus stridulus and has been considered by some a reflex spasm due to adenoids. The theory that it is due to hypertrophy of the thymus gland is strenuously advocated by Hochsinger, who moreover finds a large proportion of cases exhibiting a condition of rickets often with coincident enlargement of the spleen. Others believe that it is caused by paralysis of the posterior crico-arytenoid muscle, or compression by bronchial glands. It seems probable, however, that it is due simply to unusual flaccidity of the laryngeal structures (Sutherland and Lack). The epiglottis folds on itself and the resilient walls of the larynx tend to collapse, thus impeding respiration. The condition is rarely dangerous and ordinarily requires no special treatment. Examination of the larynx is not easy and it might be difficult to differentiate this condition from that resulting from papillomatous growths or membranous obstruction.

After a very thorough study of the subject, A. Logan Turner and John Thomson reach the following conclusions: that the stridor is due to disturbance of respiratory coordination probably resulting from faulty or retarded development of the cortical center; that the

altered conformation of the larynx is not congenital but is merely an exaggeration of the infantile type resulting from the constant sucking in of the aperture of the soft larynx in the peculiar breathing; that the sound is not pharyngeal nor tracheal, but is made in the larynx; that this neurosis is not due to adenoids or other reflex irritation. They believe that enlargement of the thymus or lymphatic glands is not concerned, because these lesions were not found in several cases examined post mortem, and because in two cases of pressure from enlarged glands the stridor was chiefly expiratory, the larynx did not move up and down in respiration, and respiratory distress was much more marked than it commonly is in cases of intralaryngeal obstruction. It is supposed that the stridor in the class of cases under discussion is produced partly in the larynx and partly by abnormal approximation of the aryepiglottic folds.

A very rare and curious phenomenon has been described under the name of "laryngeal whistling." A recent case was that of a boy of thirteen who produced a strange shrill whistle with the mouth wide open. It was possible to examine the boy with a mirror, but it was found in the production of the sound that the epiglottis was forcibly drawn downward so as to prevent a view of the interior of the larynx; hence, it was impossible to determine precisely the origin of the sound, whether produced in the chink formed by forcible retraction of the epiglottis, or by the aryepiglottic folds, or by an extraordinary degree of tension of the cricothyroid muscles over which the patient may have had an unusual amount of control. It has been suggested also that this lad might have caused the sound with a membranous formation similar to the syrinx of birds. In a similar case reported several years ago by John O. Roe it was possible to study the parts during production of the sound, the patient being an adult and very manageable. This observer concludes that the whistle was produced by vibration of the vocal bands only in their middle third, the limitation of their action being assisted by contraction and depression of the ventricular bands. In high tones the arytenoids were seen to be forcibly drawn up under the epiglottis. A similar mechanism was found in the case of a professional ventriloquist in producing the primary ventriloquial tones, although he could not make a laryngeal whistle. The explanation here offered was confirmed by Elsberg in two cases of his own, and several other examples of this curious phenomena are quoted. A different ex-

planation is given by G. Hudson Makuen, and it may be that the feat of laryngeal whistling is capable of performance in various ways. He had an excellent opportunity to study the condition in the case of a young man who could whistle a tune with his mouth open. He found and was able to demonstrate to others that the aryepiglottic folds were pursed up precisely as the mouth is in whistling and that no other part of the larynx was used, the vocal bands having no more share in the laryngeal whistle than in the ordinary lip whistle. In still another case reported by C. E. Munger the ventricular bands seemed to be chiefly concerned, space for the air blast being left at the posterior fourth of the vocal bands which were elsewhere in firm contact.

PARALYSIS OF THE LARYNX.

Interference with the action of the laryngeal muscles may be of myopathic origin or referable to some lesion of the nervous system, either central or of one of the laryngeal nerves in continuity. A typical example of the former is seen in the aphonia occurring in tuberculous laryngitis, due, in part, to mechanical interference with muscular movements by infiltration at the posterior commissure, and, in part, to a general muscular atony.

A very common form of myopathic paralysis occurs in the loss of power of the thyroarytenoid muscles resulting from overuse of the larynx when inflamed. Fatigue from muscular strain, whether in speaking or singing, often results in this condition. The thyroarytenoid muscles are the most important and interesting of the intrinsic muscles of the larynx as regards purity and sweetness of tone. Some of their fibers are distributed to the margin of the cord and are capable of limiting vibration to one portion of the vocal band. It is easy then to appreciate how inflammation of the bands may interfere with their delicate mechanism. Impairment of the action of these muscles produces very marked alteration in timbre and range of the voice, which is weakened or altogether lost. The laryngoscopic picture is perfectly characteristic and unmistakable. Instead of a close approximation of the cords an elliptic opening from the vocal process to the anterior commissure remains on attempts at phonation. A similar picture is presented, only to a more marked degree, when the cricothyroid muscle is paralyzed (Fig. 141).

The arytenoideus muscle is affected by lesions of the inferior as well as of the superior laryngeal nerve (Fig. 142). When the latter nerve is involved the cricothyroid muscle is paralyzed, an elliptic opening, as in thyroarytenoid paralysis, is seen and a triangular space exists at the posterior commissure, the vocal bands being in contact only at the vocal processes. This muscle may also suffer in connection with a chronic catarrhal laryngitis, in



FIG. 141.—Bilateral Paralysis of Internal Thyroarytenoids.



FIG. 142.—Paralysis of Arytenoideus.

incipient tuberculosis, in diphtheria and in hysteria. The voice is hoarse, feeble, or entirely lost, attempts at phonation being very tiresome owing to waste of air in the expiratory blast (Fig. 143).

Bilateral paralysis of the lateral cricoarytenoids is a very rare condition. The laryngeal image is almost identical with that of bilateral paralysis of the recurrent laryngeal nerve. It may result from lead-poisoning, diphtheria, or from one of the exanthemata.



FIG. 143.—Paralysis of Internal Thyroarytenoids and of Arytenoideus.

Unilateral paralysis is also very infrequent and is due to causes similar to those just mentioned. It is characterized by impaired rather than complete loss of voice, the unaffected cord attempting to compensate for the paralysis of the opposite cord by crossing the middle line, the arytenoid cartilage on the sound side passing in front of the opposite arytenoid.

The *prognosis*, in all these forms of paralysis, is favorable provided we can place the patient under proper conditions.

The first indication is to secure rest for the larynx; in the second place, to remove the cause of the affection if it can be discovered. Electricity, by means of faradism or galvanism, may be used every day for ten or fifteen minutes, one electrode being placed within the larynx, the other externally. The general health should receive attention and the use of tonics, exercise, full diet and strychnia to its physiological effect, will assist recovery.

The most common form of paralysis of the vocal bands due to nerve lesion is *recurrent laryngeal paralysis*, which is traced, in a large proportion of cases, to pressure upon the recurrent laryngeal nerve at the root of the neck by aneurysm of the arch of the aorta,



FIG. 144.—Partial Paralysis of Right Recurrent during Respiration.

by enlarged lymphatic glands, mediastinal tumors, or esophageal growths, or by pleuritic adhesions at the apex of the lungs in tuberculosis. The last mentioned cause is met with more frequently upon the right side than upon the left. A central lesion from cerebral apoplexy, embolism, or occurring in the course of locomotor ataxia, may lead to similar phenomena. The neuritis following diphtheria or typhoid fever may also result in paralysis of the inferior laryngeal nerve. In this condition the cord affected assumes the cadaveric position midway between abduction and adduction, the apex of the arytenoid being tilted forward. The unaffected cord crosses the middle line in phonation to meet the opposite cord, the sound arytenoid passing in front of the paralyzed arytenoid, giving a very distorted laryngeal picture. The loss of voice is usually not very marked, complete aphonia being the rule only when both recurrent nerves are affected. Paralysis of one nerve usually develops slowly and, as it progresses, the opposite cord has time to

compensate for the loss of action on the part of the paretic vocal band (Fig. 144).

The *prognosis* of recurrent laryngeal paralysis depends upon the location of the disease and upon its duration. When it has existed for many months degenerative changes may have occurred in the muscles which cannot be overcome (Fig. 145).

The *treatment* should be governed by the nature of the cause of



FIG. 145.—Partial Paralysis of Right Recurrent during Phonation.

the affection. Post-diphtheritic cases recover under tonic doses of strychnia and the use of electricity. These methods, of course, should not be used in cases of paralysis due to aneurysm or to pressure upon the trunk of the nerve, although there is no objection to exercising the intrinsic muscles of the larynx by means of the faradic current if there is any hope that the function of the nerve may be eventually restored (Fig. 146).



FIG. 146.—Complete Right Recurrent Paralysis on Phonation.

A lesion of the *superior laryngeal nerve* results in complete anesthesia of the laryngeal mucosa as well as in paralysis of the cricothyroid and occasionally in paresis of the arytenoideus, in some cases the superior laryngeal nerve sending a few motor fibers to the latter muscle. The loss of sensation is sometimes an important feature necessitating artificial feeding, since anesthesia of the larynx may lead to inspiration of particles of food which would not be promptly rejected.

The laryngeal picture has been referred to in speaking of paralysis of the arytenoideus muscle, the only parts of the vocal bands in contact being the vocal processes, an elliptic opening remaining anteriorly and a triangular opening posteriorly during phonation. A large proportion of these cases result from diphtheria.

Recovery may be spontaneous in the course of a few months or may be deferred a year or more, but it is expedited by judicious treatment, counter-irritation, stimulation with electricity, massage and tonics. In this, as in most other forms of paralysis, care should be taken to avoid overuse of the voice and all intercurrent inflammatory conditions should receive attention.



FIG. 147.—Partial Paralysis of Posterior Cricoarytenoids during Respiration.

Paralysis of the abductors, or posterior cricoarytenoid muscles, may be bilateral or unilateral. The most frequent cause of bilateral abductor paralysis is a syphilitic lesion involving the special nerve center. It may occur in locomotor ataxia. Again, it may be due to lesions in the course of the nerve, such as neoplasm, aneurysm, or goitre. It may occur in lead-poisoning and is said to follow toxemia from various other chemical poisons (Fig. 147).

The dyspnea resulting from this condition comes on by degrees and is inspiratory. It is distinctly progressive, is aggravated by exertion or excitement and may become at any moment of serious import. Expiration is less affected and the voice is unchanged except, perhaps, being slightly weaker than normal.

In the mirror, the image on phonation is unaltered; but, during respiration, the cords are seen lying near together in the middle line instead of being abducted.

The treatment depends upon the cause discovered. If of syphilitic origin the disorder may be remedied by the administration of iodide of potassium, pushed to its fullest extent, at the same time, the muscular tone being preserved by means of electricity. The

possibility of sudden laryngeal stenosis should be kept in mind and the probable necessity of intubation or tracheotomy. The latter is preferred. In a case of my own in which the paralysis followed extirpation of a goitre, an intubation tube was worn for a short time but became so irksome to the patient that she insisted upon the trachea tube being introduced. The obvious advantage of the latter is that with the trachea tube *in situ* the patient is still able to phonate, which is not the case with an intubation tube. Sudden death occurring in a tabetic may be due to ischemia of the respiratory center in the medulla rather than laryngeal obstruction. Here inversion of the patient and artificial respiration are demanded. It has been proposed in inveterate cases of bilateral abductor paralysis to split the larynx and excise the paralyzed cords, a radical mode of treatment which has not received universal acceptance. Section of the recurrent laryngeal nerves which would result in placing the cords in the cadaveric position and, at the same time, abolish the voice, has been suggested by Krause. Section of the nerve of *one side only* might be expected to give adequate breathing space without destroying the voice. Unfortunately the object is defeated by fixation of the cricoarytenoid joint, or by *shortening of the adductors*, a result of long unopposed contraction, which still holds the cords in the middle line.

Unilateral paralysis of the abductor may be due to causes similar to those acting in the case of bilateral paralysis, except that it has never been known to follow a central lesion. The voice is preserved and nothing anomalous is to be seen in the mirror during phonation, but on inspiration the affected cord occupies the middle line, while the sound cord is abducted in a normal way. Active treatment is seldom called for, except in syphilis, since the symptoms are usually unimportant.

The preponderance of abductor over adductor paralysis has led to the enunciation by Felix Semon of a law ascribing to the posterior cricoarytenoid muscles, the only abductors of the vocal bands, an especial vulnerability, in consequence of which adduction of the cords is the phenomenon first noticed in general laryngeal paralysis. The question has been hotly discussed. Recent investigations by Grossman seem to show that after division of the recurrent nerve the vocal bands assume a median position for a few hours or days, as the case may be, gradually becoming cadaveric. The primary position in

adduction he explains by temporary action of the cricothyroid and the external muscles which, of course, are not affected by abolition of the function of the inferior laryngeal nerve. This view, however, drawn from experiments on the cat, is opposed by the best authorities who find that in human beings the bands at once become cadaveric on section of the recurrent. A possible explanation of a posticus vulnerability may be found, as suggested by Grabower, in a peculiar difference in the way in which the nerve terminates in the abductors and in the adductors, in the latter its endings being broader and firmer. Hence we might expect the innervation of the adductors to be more vigorous and resistant than that of the abductors. Whatever explanation of the fact may be offered the majority of observers agree that under electrical stimulation the laryngeal adductors exhibit more vitality than the abductors. In studying the innervation of the larynx confusion is apt to arise from the fact that the nerves of either side may cross to supply the muscles of the opposite side. Moreover, many observations have established the fact that motor fibers from the superior laryngeal nerve sometimes pass to the adductor muscles. The whole question is so intricate and opportunities for observing paralysis of the larynx are so rare that a final solution of the problem has not been reached.

In relation to the question of laryngeal paralysis it may be of service to keep in mind the following propositions.

1. All intrinsic muscles of the larynx are attached to the arytenoid cartilages, except the cricothyroid.
2. The cricothyroid arises from the thyroid cartilage and is inserted into the cricoid, hence in contracting it pulls up the anterior border of the latter, tilts the arytenoids backward and makes tense the vocal bands, in the meantime the thyroid cartilage being immovably fixed by the action of the external muscles, the sternothyroid and the thyrohyoid.
3. The superior laryngeal nerve is the sensory nerve of the larynx, but sends motor fibers to the cricothyroid muscle and sometimes to the arytenoideus.
4. The inferior, or recurrent, laryngeal nerve gives motor fibers to all the intrinsic muscles, except the cricothyroid.
5. Nerve fibers in the vagus supplying antagonistic muscles run in separate bundles throughout the length of the recurrent nerve.
6. Adjacent cortical centers at the lower end of the ascending

frontal convolution exist for both the adductors and the abductors and are bilateral in action. Hence bilateral *spasm* of the larynx follows irritation of the cortical center of either side, that of the adductors predominating because of the greater strength of these muscles.

Owing also to the bilateral action of the cortical centers laryngeal *paralysis* seldom results from a unilateral cerebral lesion.

7. In progressive disease affecting the innervation of the larynx the abductors are the first to succumb to paralysis and atrophy. If recovery takes place the reverse course is pursued and the adductors are first to regain tone.

8. In *complete* recurrent paralysis the vocal bands at once assume a cadaveric position, midway between adduction and abduction.

It is desirable but often quite impossible to differentiate between paralysis of the vocal bands and *ankylosis* of the cricoarytenoid articulation. Disturbance in the joint may follow exposure to cold, infection, rheumatism, tuberculosis, or traumatism. A feeling of discomfort or of slight pain on swallowing or when lying down may be complained of. It is difficult for the patient to locate the sensation but it may be defined by palpation over the cricoid in the neighborhood of the joint. The pain is to be distinguished from that present in an aggravated degree of hyperesthesia of the superior laryngeal nerve by the fact, affirmed by Grünwald, that in the latter pressure must be applied at "the upper lateral border of the thyroid at its center." In some cases crepitation is detected. In the laryngeal mirror nothing abnormal is seen until periarthritic swelling supervenes. The movement of the vocal band on the affected side, instead of being smooth and gliding, is uneven and jerky, or the excursion of the band on attempts at phonation is incomplete or entirely absent. If the band is fixed in a position simulating that of one of the forms of paralysis it is possible to make a diagnosis only by excluding the probable causes of disturbed innervation. In most cases of ankylosis there is more or less permanent thickening about the joint, which is not a feature of paralysis. A position of a vocal band unlike that of a neurosis, a jerky movement of the band on phonatory efforts, and finally variable motility, or in other words more freedom of motion at one time than at another, are presumptive evidence of cricoarytenoid arthritis. The case is strengthened by a distinct history of rheumatism, of syphilis, or of tuberculosis. The greatest difficulty arises in connection with cases of complete

fixation of the cricoarytenoid joint without thickening. A most important point, especially noted by Watson Williams, is the relation to each other of the arytenoids. Their relative positions in paralysis have been described: in ankylosis the sound arytenoid on phonation does not cross the crippled one, pushing it aside, but merely crowds up against it without displacing it. In certain old cases of paralysis the joint may become ankylosed from disuse, so that the point last mentioned is not invariably reliable.

CHAPTER XXIV.

FOREIGN BODIES IN THE LARYNX. PROLAPSE OF THE VENTRICLE.
FRACTURE OF THE LARYNX.

FOREIGN BODIES IN THE LARYNX.

The subject of foreign bodies in the larynx carries the laryngologist somewhat beyond the limits of his territory, since in many cases a body supposed to have entered the larynx is found not in that cavity, but in the pharynx, the trachea, or a bronchus. It will be convenient, therefore, not to confine this consideration strictly to the larynx.

The importance of a foreign body in the larynx depends upon the shape and size of the object and upon its point of lodgment. Fatal asphyxia may follow the inspiration of a very large body, whereas a small sharp-pointed object, like a fish-bone, pin, or piece of glass, may not interfere seriously with the air current. An object with rough, irregular surfaces is much more apt to be caught in the laryngeal cavity than one with a smooth surface. A glass bead, for example, is likely to slip through the glottis, lodge in a bronchus and become the source of very serious mischief. A case which attracted great attention several years ago was that of a well-known clergyman who inhaled a cork he was holding between his teeth (Rushmore). The body passed directly through the larynx and lodged in a bronchus. Efforts to remove it through an opening in the trachea were unsuccessful and death from pneumonia finally ensued. The feasibility of reaching the foreign body in cases of this kind by a bronchotomy done from behind has been suggested. Almost any object that the mouth can hold is liable to be drawn into or toward the glottis so as to impede respiration. Children particularly have a fashion of putting everything in the mouth; whence, in deep inspirations preceding laughing or coughing there is danger of the foreign body being sucked into the lower air-tract.

Usually the signs of invasion of the larynx by a foreign body are unmistakable; but, it is remarkable that one, even of large dimen-

sions, under some circumstances, may be retained for a considerable time without producing much disturbance. Several years ago I reported a case of tooth-plate, which fell into the larynx during a puerperal convulsion and was not discovered until one week later when the patient complained of sore throat. Lennox Browne, a few years ago, recorded a case in which a plate of artificial teeth was impacted in the larynx twenty-two months before it was recognized. S. W. Langmaid once removed a pin from the larynx two years after it had been inhaled, in the meantime hoarseness being the only symptom. Johnston's famous case of a toy locomotive, impacted in the larynx and removed several months after a tracheotomy for relief of the immediate symptoms, is probably unique.

In a large proportion of cases collected by Durham spontaneous expulsion took place in from one to seventeen years, and Gross records a case in which a piece of bone was retained in the air passages for more than 60 years. Cameron's case of a penny in the larynx for six years, and Cohen's two remarkable cases in which a foreign body, one of them a pebble stone, remained in the air-tract for ten years without doing much damage, are noteworthy. From a thorough study of this point Wood concludes that spontaneous relief may be expected in about 57 per cent. of cases. In spite of this rather favorable showing and in view of the success attending modern methods of operating, the opinion of Weist that a patient with a foreign body in the trachea or a bronchus is more likely to recover if let alone is not shared by the majority of surgeons. The extension to the trachea and bronchi of Kirstein's plan of direct inspection has doubtless been the means of rescuing many a desperate case. Manipulations under guidance of the eye are beyond question more precise and effective than blind groping with forceps or probe.

In striking contrast to the tolerance displayed in cases like those just mentioned is the violent and prolonged spasm often excited by a drop of water or a crumb of bread which may barely get into the larynx in that unpleasant phenomenon known as "swallowing the wrong way." Occlusion of the trachea has been known to follow the escape of caseous material from an ulcerating bronchial gland, and vomited matter not infrequently finds its way to the larynx, especially in the newborn, in weaklings, in alcoholics and during anesthesia. Numerous instances of lumbricoids in the larynx, many of

them fatal, have been recorded, and the introduction of leeches in drinking water seems to be a not uncommon accident in certain countries. A single instance in which the tip of the epiglottis curled back and became engaged in the rima glottidis so as to induce dangerous symptoms has been recorded by Ruehle. Cases in which an elongated uvula has not only irritated the larynx but caused serious embarrassment to breathing have come under my observation. In one in particular the patient was supposed to have edema of the glottis. Several cases in which the fragment of a broken dental or surgical instrument has fallen into the larynx have been reported, and no less than twenty examples of broken or corroded trachea tubes dropping into the windpipe are to be found in literature. When a foreign body finds its way still lower in the air tract it is almost sure to get into the right bronchus owing to the fact that the division between the bronchi is to the left of the median line. According to Poulet, another reason is the greater force in the current of air going to the right lung with its relatively larger capacity.

The first symptom excited by a foreign body in the larynx is a paroxysm of coughing which, in some cases, is successful in expelling the intruder. Spasmodic contraction of the muscles in violent efforts at coughing may, on the other hand, drive a sharp-pointed body into the wall of the larynx where it will remain until removed by artificial means. Hemorrhage may be excited by a body of this character. Bosworth narrates an unusual case in which repeated attacks of hemoptysis were apparently caused by a calcareous mass resembling a tooth lodged in a bronchus without giving any physical signs. The bleedings ceased after the foreign body had been expelled by coughing. In all cases in which the accident is suspected attempts at laryngeal examination should be made but, owing to the perturbation of the patient, it is often impossible to get any view. Under these circumstances it often happens that a mistaken diagnosis is the result. The symptoms have been attributed, in some cases, to croup or whooping-cough. In a very extraordinary case referred to by DeForest Willard a tracheotomy was done and prolonged search made for an article afterward found in the child's pocket, certain lung symptoms which were present being due to a pneumonia developing from ordinary causes.

In a case of my own in which the voice was lost and no other symptom was present after the first disturbance the electric current

was applied to the larynx for more than a week with the hope of restoring the lost vocal function; at the end of that time a laryngeal examination discovered, lodged in the ventricle of the larynx near the anterior commissure, a *shoe-hook*. Six weeks later the boy was brought to my clinic where, after several ineffectual efforts at extraction through the mouth, I performed partial laryngo-fissure and removed the hook. Recovery was complete and, in the course of six weeks, perfect use of the voice was regained. It is claimed that Kirstein's method of examining the larynx in children under these circumstances, is particularly successful. An almost identical case has been reported by E. Fletcher Ingals, but in the latter the foreign body was pushed upward by means of a Trousseau tracheal forceps and then extracted with the finger passed into the mouth.

In every case, unless the symptoms be urgent, in which the presence of a foreign body in the air-tract is suspected a careful laryngoscopic examination should be made before attempts at removal are undertaken. In many cases a tracheotomy for relief of dyspnea must be done at once, and an examination made later. The precise location of a foreign body may be defined by means of the Roentgen rays when it cannot be discovered by inspection. Little or no reliance should be placed on the statement of a patient as to its situation, since subjective sensations are altogether misleading. It is a very common experience for a patient to point with confidence to the exact spot, where nothing can be detected except slight redness, or perhaps an abrasion or scratch made in transit by a foreign body which has been swallowed. These *imaginary* foreign bodies comprise a very large proportion of those which the surgeon is called upon to remove. On the contrary, a pin or a small fish-bone may become embedded in a lymph follicle at the base of the tongue, or in a tonsillar crypt, where it may readily elude a superficial search. Here the use of a probe to push aside folds of mucous membrane is often of service. Rough palpation with the finger is unwise, because a sharp object may be pushed still further into the tissues, or a movable one may be dislodged and fall into the larynx.

The management of foreign bodies in the larynx demands the exercise of great ingenuity and dexterity. As examples of clever devices employed for their removal may be mentioned the electro-magnet in the case of metallic articles (Voltolini, Garel and Goul-lioud), a sponge after Voltolini's method (Max Thorner) and cotton

wool wound on the end of the finger (Crawley) in the case of a cockle-burr in the larynx, and finally a brush dipped in mucilage to extract a thread (Brandeis). When the stenosis is due to spasm rather than to the volume of the object the inhalation of chloroform or the local use of cocaine is of advantage. An impacted body which interferes but slightly with breathing may be dealt with somewhat deliberately. A smooth movable body is more dangerous because of its liability to shift its position and fall into a bronchus. A sharp-pointed or angular body, if roughly handled, may damage the wall of the larynx excessively, may even cause emphysema of the cellular tissue, or induce hemorrhage by penetrating a blood-vessel.

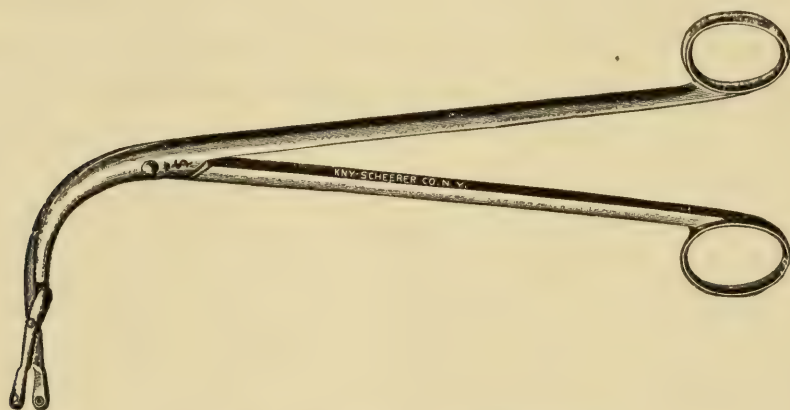


FIG. 148.—Cusco's Laryngeal Forceps.

It is sometimes necessary to break up and remove piecemeal an irregular object. A pin, lying in the larynx with point upward, must, if possible, be seized and pushed downward before any attempt is made to withdraw it. In adults, as a rule, the manipulations are conducted under local anesthesia with cocaine. In children, general anesthesia is not infrequently demanded. In young subjects, the interior of the larynx may often be reached by the tip of the finger. If the body is seated high up it may be removed by hooking the finger beneath it. In other cases we have to choose one of the various laryngeal forceps. Mackenzie's, or Cusco's (Fig. 148) or if preferred tube-forceps, or the cold-wire snare is selected according to circumstances. If an unwarrantable amount of force is needed to dislodge an impacted body the alternative of external operation is presented. In the latter case we should hold before us the importance of preserving the function of the larynx by accurate replacement of the vocal bands, an object not easy of accomplish-

ment if section of the thyroid cartilage has been complete. To secure perfect apposition of the halves of the larynx it is well, therefore, to leave the upper margin of the cartilage undivided. This mode of procedure, especially in young subjects in whom the parts are pliable, does not interfere with a satisfactory exposure of the interior of the larynx. In order to prevent reflex inhibition of heart action applications of cocaine to the mucous membrane both before and during a fissure of the larynx are recommended, and great care should be taken to keep the incisions in the middle line.

Since the technical details of tracheoscopy and bronchoscopy have been brought so near perfection by Killian, Bruenings and Chevalier Jackson, the necessity of an external operation for removal of a foreign body is well-nigh abolished. In young children owing to narrowness of the air-tract and the danger of provoking edema of the glottis, and when the foreign body is caught at a remote point, it is judicious to select a *low bronchoscopy*, the tube being passed through a tracheal opening. By *upper bronchoscopy*, the tube being introduced through the larynx, it is often possible to reach even the secondary divisions of the bronchi. Essentials to success are (1) thorough anesthetization, local in adults, general in children, (2) tubes of proper shape, length, and caliber, (3) good illumination, and (4) suitable extracting instruments. Various modifications are required depending on the size, form and location of the object to be removed. In many cases these points are positively determined by the skiagraph. The source of light is most important. In the Killian-Bruenings' instrument the light is at the proximal end and the rays are projected along the tube by an ingenious arrangement of magnifying lenses. This mechanism has been modified by Jackson (Fig. 149), who has placed a lamp at the *distal* end of the tube, by which more brilliant illumination with less waste of light is secured and manipulations are much simplified. It is interesting to note that statistics gathered by Coolidge show a mortality of only 8 per cent. in bronchoscopy operations, as compared with 22 per cent. by other methods.

The use of emetics and experiments with inversion in children should not be resorted to unless we are prepared to open the trachea, since the foreign body may be propelled from below to a position in which it may completely block the lumen of the larynx. This

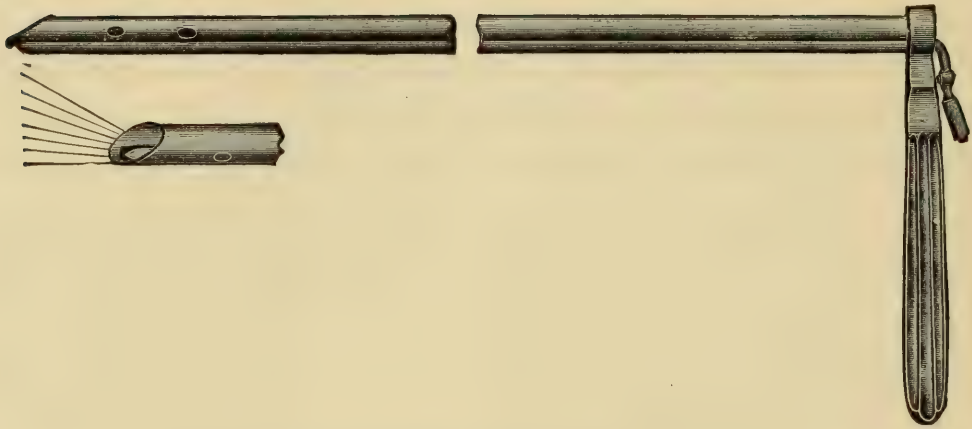


FIG. 149.—Chevalier Jackson's bronchoscope with slanting end to facilitate introduction.

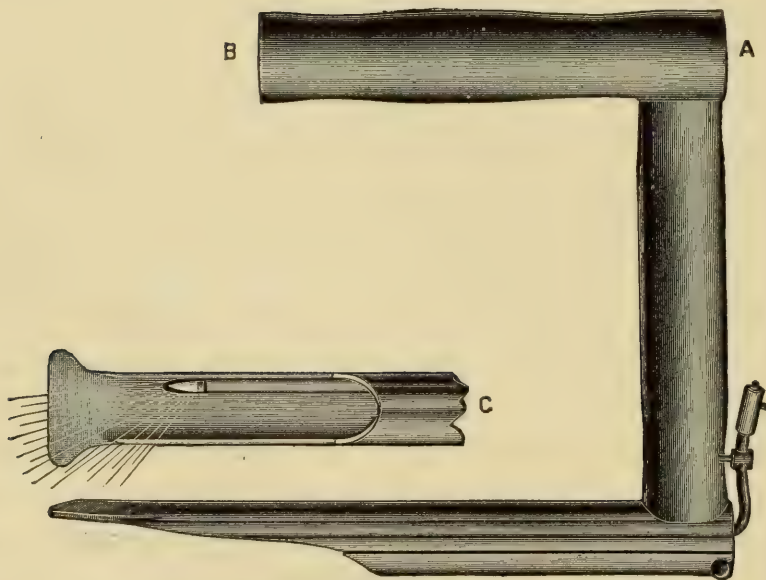


FIG. 149 a.—Separable speculum for passing bronchoscopes. The detachable handle (A B) is needed for locally anesthetized patients in the sitting position or when the speculum is held by an assistant. (D. B. Kyle.)

The reader is referred to Chevalier Jackson's work on Tracheo-Bronchoscopy for complete information as to manipulative details.

especially applies to a body known to be jagged or irregular in contour. If it has passed beyond the larynx Weist advises never to try inversion without a preliminary tracheotomy. If the trachea must be opened it is well to enter at as low a point as possible, to make a long incision and possibly to resect a part of two or more tracheal rings in order to provide for easy exit of the foreign body in case it should be dislodged by coughing. The method of inversion proposed by Padley is applicable to adults and comparatively free from danger. The patient is made to lie on his back with his knees flexed over the end of a bench which is considerably higher than the opposite end. He should inspire deeply and not attempt to speak. forcible concussion of the chest sometimes helps to dislodge the foreign body. The supine position favors its escape and should it impinge upon the chink of the glottis the patient is readily able to resume an upright posture. In Roe's collection of seven hundred and sixty-three cases of foreign bodies in the air-passages we find only three relieved by inversion and six by emesis when the larynx was involved, while nine recovered after inversion and two after the use of emetics when the substance was in the trachea. From an analysis of the combined statistics of Weist (one thousand cases), Durham (seven hundred and six cases), Gross (one hundred and eighty-three cases), and his own, Roe concludes that a foreign body should not be allowed to remain in the air-passages for any length of time without operation in case attempts at extraction by other means have failed. When the larynx is occluded by a large foreign body, or by the spasm its presence excites, the trachea should be opened without delay, though the patient appears to be moribund or even dead. The discouraging opinion attributed to Louis that in cases of this kind we are helpless because *no interval* exists between perfect health and death seems to be unfounded, in view of the success attending artificial respiration and similar restorative measures in analogous conditions. A rapid tracheotomy followed by judicious and prolonged artificial respiration will sometimes save a case apparently desperate. Coins and flat objects that are apt to take a transverse position in the larynx are conveniently reached with Watson Williams' forceps. A coin in the esophagus has several times been successfully extracted with Smith's coin-catcher. The ingenious instruments designed by W. C. Morton for use in direct bronchoscopy are well adapted to objects of this kind. Opposite the

cricoid, the narrowest part of the gullet, a foreign body is most likely to be arrested. Coolidge once removed a foreign body from the right bronchus by passing an alligator forceps along a urethro-scope which had been introduced through a tracheotomy wound. The gradual solution of fish bones by means of vinegar and of meat bones by a dilute solution (1 to 5 per cent.) of hydrochloric acid has been suggested. A fish hook with its barbed point embedded in the tissues would seem to be almost impossible of removal by any internal method, but Christison's scheme of threading the wire attached to the hook through a hole drilled in the ball of a probang was highly successful in one case. Fortunately the wire had not been swallowed and it served as a guide to the bulb of the probang which latter so dilated the walls of the esophagus as to loosen the point of the hook and allow it to be withdrawn without catching. In the larynx a similar plan would not be feasible and an external operation would be the only alternative, either a subhyoid pharyngotomy or a laryngotomy. In a case in my clinic at Cornell Medical College a metallic heel plate was removed by Mack from the laryngopharynx of a shoemaker who was in the habit of holding these objects in his mouth while at work. Three sharp prongs projecting from the surface of the plate had to be disengaged by pressure with the finger, in the meantime traction being made on the plate which had been seized with canula forceps. Very little reaction followed, although the plate had been in the pharynx eight or ten hours, and had excited almost constant and irresistible desire to swallow.

It is seen, therefore, that every case of foreign body in the larynx, or in neighboring regions, presents features peculiar to itself which must be met according to circumstances.

PROLAPSE OF THE VENTRICLE OF THE LARYNX.

Prolapse of the ventricle of Morgagni is a rare condition, very apt to be confounded with a new growth or with a simple inflammatory hyperplasia. It consists of protrusion of the sacculus laryngis as a result of sudden voice-strain or violent coughing, possibly in conjunction with atony or paresis of the muscle known as the compressor sacculi laryngis, or Hilton's muscle. In one case in my experience a protruding mass simulating prolapse of the ventricle was

excised, when it proved to be a tuberculous infiltration. Serious doubt as to the possibility of eversion of the ventricle was suggested long ago by Fraenkel and by Chiari. Moure believes that the condition of apparent prolapse is really one of chronic inflammation, and this view has received recent confirmation by Noack, who found that the tissues of a supposed everted ventricle were composed of vascular and edematous hypertrophies. It is maintained by Schroetter that an apparently prolapsed ventricle is in reality an example of chronic subglottic laryngitis, the thickened and projecting tissues giving the misleading impression of a tumor which seems to spring from the site of the ventricle.

The treatment consists simply in replacement of the ventricle by means of a laryngeal probe and of faradization of the muscles of the larynx together with prohibition of the use of the voice for a considerable period. It may be found impossible to restore the prolapsed sacculus, in which case ablation would be the proper procedure, provided the subjective symptoms are very pronounced.

FRACTURE OF THE LARYNX.

Fracture of the larynx is a rare accident and may result from direct violence, as from a blow or by choking, from bullet wounds, or from muscular action during a violent paroxysm of coughing (Sajous). A large proportion of cases have been observed in early life, so that ossification of the cartilages incident to old age cannot be regarded as a predisposing factor.

In most cases the thyroid alone is fractured, but in many the cricoid also is involved and in a few the hyoid bone is broken.

External deformity is at once quite marked either as a depression or an unusual prominence of the thyroid, accompanied by more or less swelling of the external soft parts. If the mucous lining of the air-tract is lacerated hemorrhage may occur, and aphonia and cough with blood-streaked sputa are prominent symptoms. Dyspnea is present early or not for several days after the accident. Emphysema may be limited to the neighborhood of the injury or may be diffused over the whole body, as in the case of a child six years old reported by Hume. The foregoing symptoms, together with crepitation on palpation, should establish the diagnosis. In severe cases when the cartilage is comminuted or the fracture is compound, but

little doubt can exist. In simple cracks or linear fractures there is more difficulty. The prognosis in cases of the latter class is favorable. A penetrating wound over the thyroid cartilage is demonstrated by blood-stained sputum and impairment of voice, the latter remaining permanent.

In treatment the first indications are to replace distorted fragments and control inflammatory reaction by cold affusions. Swelling and edema may necessitate a tracheotomy or intubation. The latter is preferable, both with a view to supporting depressed fragments of cartilage and to preventing contraction of the air-tube during the process of repair. An O'Dwyer intubation tube as large as the larynx will accommodate should be selected and its introduction is facilitated by preliminary spraying with cocaine and suprarenal extract. In a case reported by W. K. Simpson a very large, somewhat conical, tube was used which served as a dilator as well as an air-tube. In cases of extensive damage an intubation tube does not reach far enough and the only alternative is an opening in the trachea at the lowest possible point.

THE EAR.

CHAPTER XXV.

ANATOMY, DEVELOPMENT, COMPARATIVE ANATOMY, EMBRYOLOGY.

The temporal bone articulates with the sphenoid, parietal, occipital, inferior maxillary, and malar bones, and together with them forms the osseous framework of the temporal region. The outer and lower surfaces of this framework are covered with periosteum, and are in intimate relation with nerves, vessels, muscles, tendons, fasciæ, glands, and cartilages, the whole being covered with an outer layer of skin. The inner and upper surface of this bony framework is covered by the dura mater which serves as periosteum and envelope for the brain. The bone supports the temporo-sphenoidal and occipital lobes of the cerebrum and the cerebellum, forming the lateral protection of the cerebellum and cerebrum, as well as supplying an anterior wall for the cerebellum. Important nerves, veins, and arteries are brought into contact with these surfaces. This region is of great anatomical interest and of vital importance structurally, physiologically, and pathologically.

For convenience the ear may be divided into the conventional outer, middle, and inner ear.

The outer ear is the sound-collecting mechanism, and includes the most external part of the ear, the auricle, and the passage which leads to the drum—the external auditory canal.

The *auricle*, or pinna, consists of an irregularly crumpled plate of cartilage enveloped in perichondrium and covered with skin, which is closely adherent to the perichondrium in front and separated from it behind by loose areolar tissue. The lobe or appendage of the auricle is a fibrous network containing fat. The cartilage of the auricle is continuous with the cartilage of the auditory canal and is attached to the osseous canal. Sebaceous glands are abundant in the lobe and in the anterior surface of the auricle, especially in the concha or hollow of the ear. These glands are also found below and behind the auricle.

The corrugations of the surface of the auricle are sustained by fibrous adhesions of the perichondrium. The angle which the auricle makes with the side of the head is due to the adhesion of the posterior perichondrium with the post-aural periosteum.

The *external auditory canal* (or *meatus auditorius externus*) is an irregular tube, slightly compressed anteroposteriorly, with a varying amount of angular curvature; it is composed of two nearly equal portions—the outer cartilaginous, and the inner osseous. The cartilaginous walls of the canal are continuous with the cartilage of

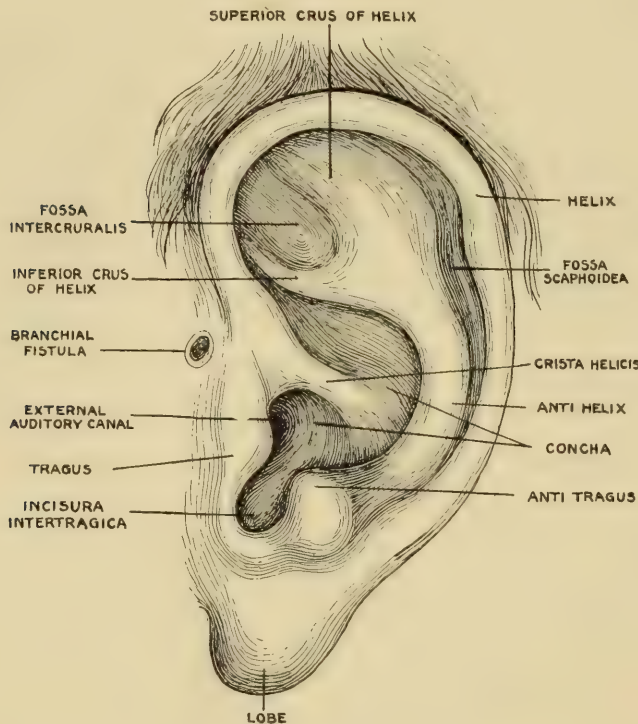


FIG. 150.—Left Auricle.

the auricle. There are several fissures in the cartilaginous part of the canal called fissures of Santorini, through which pus may burrow. The canal extends inward from its mouth, backward and upward; it then turns forward, still proceeding inward, to the junction of the cartilaginous with the osseous portions of the canal. At this point it again turns backward in a curve; finally, at the extreme inner end it curves forward and downward. The inner end enlarges somewhat, leaving a slight isthmus near the drum membrane. The upper surface at this point is slightly vaulted. The antero-inferior wall, at its inner end, combines with the drum membrane to form a pouch,

which lies beyond an elevation of the floor of the canal near the drum membrane where the isthmus of the canal is located. The antero-inferior wall is convex; the postero-superior wall, concave.

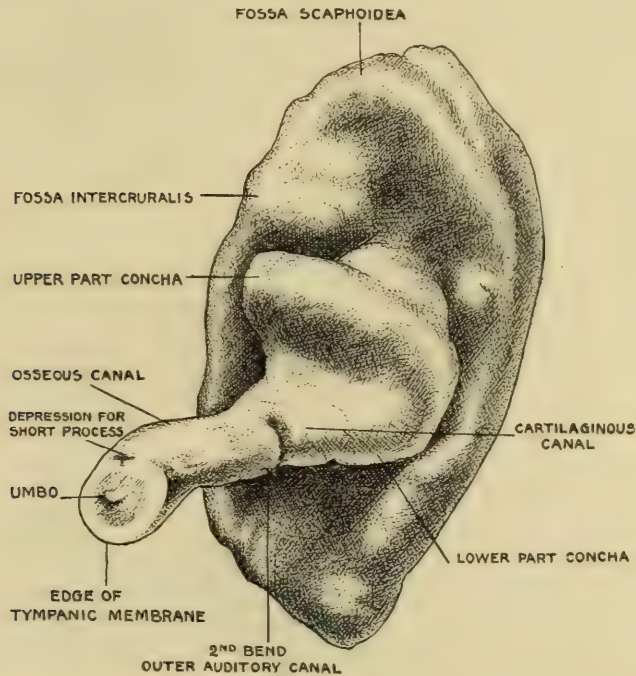


FIG. 151.—Cast of Right Auricle and Canal Cavities Viewed from Within.

The canal is terminated by the drum membrane which lies obliquely across the end. Owing to this oblique position of the drum membrane, the antero-inferior wall of the canal is much longer than

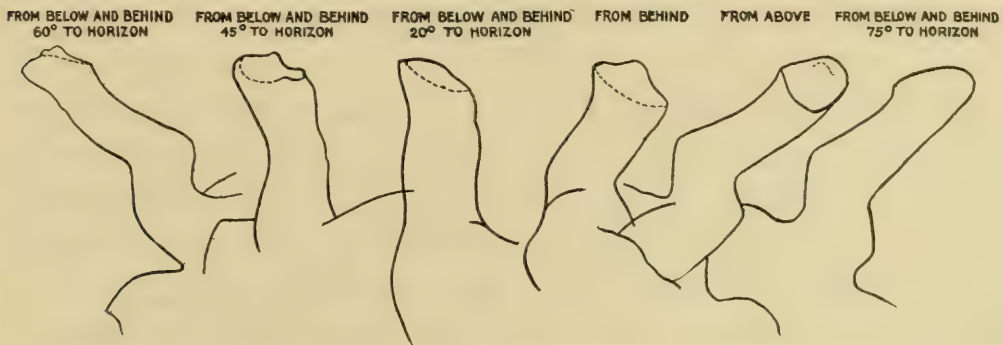


FIG. 152.—Outline of Cast of Right External Auditory Canal.

the postero-superior, being 35 mm. and 29 mm. in the adult respectively.

The *cartilaginous portion* of the canal is supplied with ceruminous glands and hairs. Its anterior wall rests upon the outer half of

the maxillary articulation and is subject to forward traction, backward movement and compression, as the jaws are opened or closed.

The *osseous part* of the canal has a rigid wall lined with a thin dermoid layer devoid of glandular structures, and closely adherent to the periosteal covering of the bone. This lining is slightly thicker along the superoposterior wall and around the attachment of the drum membrane. A vascular network lies in these localities and passes down along the handle of the hammer.

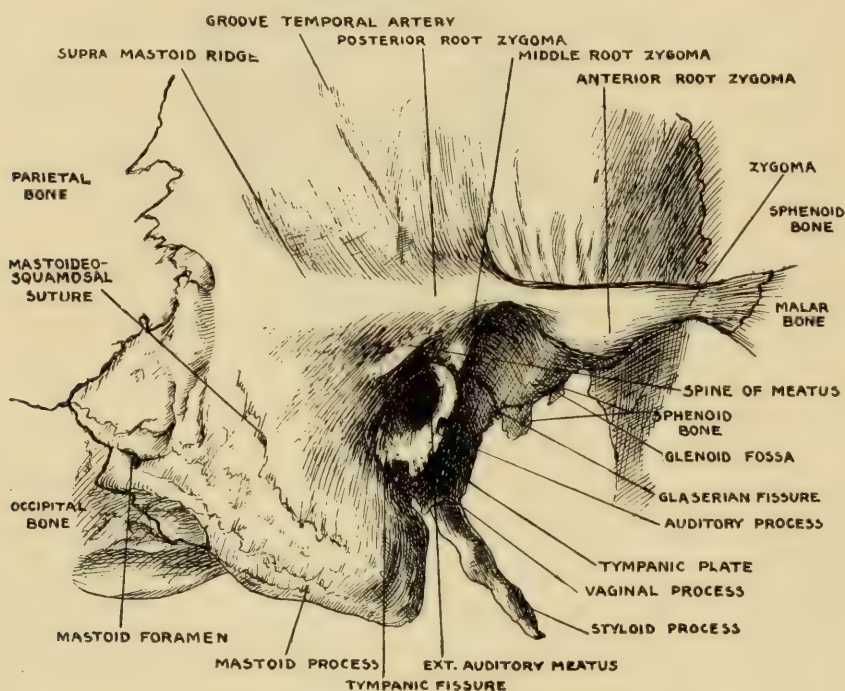


FIG. 153.—Outer Surface of Right Temporal Bone.

The inferior, posterior, and anterior walls of the osseous canal are formed by the *auditory plate*, developed from the *tympanic ring* (annulus tympanicus) and extending outward from the *sulcus tympanicus*. The lower wall of the canal forms the base of the *vaginal process* of the petrous bone, and terminates externally in the *auditory process* for the attachment of the cartilaginous portion of the canal. The anterior wall forms the posterior wall of the glenoid fossa up to the fissure of Glaser. The free external border of this wall serves for the attachment of the cartilaginous canal. The posterior wall covers the anterior aspect of the mastoid cells and mastoid antrum. The junction of the auditory plate with the mastoid portion of the temporal bone is marked inferiorly and

externally by the auditory fissure; the superior wall is formed by the horizontal plate of the squamous portion of the temporal bone. The inner end of this wall acts as the upper, outer boundary of the *cavum tympani*, or drum cavity, and the outer and lower wall of the niche of the attic or epitympanum. The *spine* of the *meatus* is placed at the external posterior edge of this wall. The posterior root of the *zygoma* forms the upper lip of the osseous canal. The middle fossa of the skull and the *temporo-sphenoidal* lobe of the brain lies above the superior wall of the canal and is separated from the canal by a thin bone of varying thickness, with or without air-cells. The inner part of the posterosuperior wall of the canal is the anterior wall of the mastoid antrum, and is quite thin because of the approximate parallelism of the antrum and auditory canal.

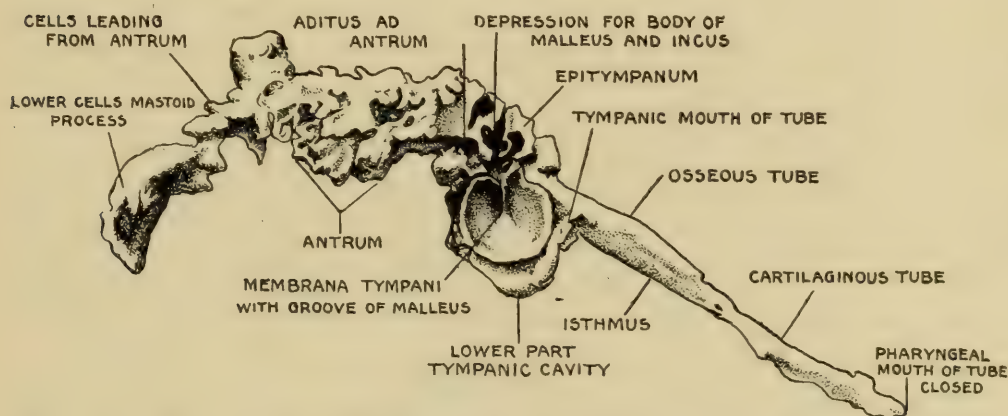


FIG. 154.—Metallic cast of Right Middle Ear Tract Viewed from the Outer Side.

The *middle ear* is the mechanism for the transmission of the sound already collected by the external ear to the inner ear, where the peripheral sound-perceiving apparatus is located. The middle ear consists of an irregular tube leading from the side of the nasopharynx. The axis of the tube lies at an angle of 45° to the three planes of the body—anteroposterior, sagittal, and horizontal. In mechanical construction, the middle ear resembles a drum, the *tympano-pharyngeal*, or *Eustachian tube* corresponding to the air-hole in the side of the drum, and the *drum membrane* to the drum head.

The main axis of the middle ear or drum corresponds to the axis of the tympano-pharyngeal tube which runs outward 45° , upward 45° , and backward 45° . The drum has but one natural

opening and this is through the tympano-pharyngeal tube. The drum and the external auditory canal are separated only by a thin membrane, the *membrana tympani* or *drumhead*.

The middle ear is divided, for pathological reasons and for convenience in anatomical description, into three parts: 1. The *tympano-pharyngeal* tube. 2. The *cavum tympani*, or drum proper, composed of the *atrium*, the part below the drum membrane, and the *epitympanum* or *attic*, the part on the inner side of the drum membrane. 3. The mastoid portion, consisting of the *aditus ad antrum* or passageway to the antrum, the antrum itself, and the mastoid cells.

The *tympano-pharyngeal*, or *Eustachian tube*, connects the *cavum tympani* with the naso-pharynx. It presents a flaring internal or pharyngeal orifice, and a flaring external or tympanic orifice, with a contraction or isthmus at the junction of the cartilaginous and osseous portions of the tube. The tube runs from the side of the naso-pharynx outward, forward, and upward at an angle of 45°.

The pharyngeal orifice of the tympano pharyngeal tube is located at about the same level as the posterior attachment of the inferior turbinate, and its anteroposterior position is about abreast of the posterosuperior angle of the vomer. The tube measures on the average 40 mm. along its anterior wall to the sulcus tympanicus. The inner 30 mm. are cartilaginous; the remaining 10 outer mm. nearest the *membrana tympani*, are osseous. The maximum diameter of the isthmus is, on the average, 4 mm.; the minimum diameter, which is horizontal, may be as small as 2 mm. The surface of the osseous part of the tube is not smooth; its walls may present small bony ridges and, at the tympanic orifice, bony spiculæ may jut into the lumen, thereby decreasing the diameter and obstructing a direct passage. The mucous lining of the tube is continuous centrally with the pharyngeal mucosa, and peripherally with the mucous lining of the *cavum tympani*. This mucous lining is composed of three layers: First, the ciliated columnar epithelium; next, a layer of lymphoid tissue; and third, a glandular layer. The layers are separated by elastic fibrous tissue. The lymphoid follicles are more abundant near the pharynx, where the membrane is thick and loose, than in the osseous portion, where it is thin, smooth and closely adherent to the periosteum.

The pharyngeal end of the osseous tube shows a jagged orifice

with the greatest diameter vertical; its upper wall is formed by the canal of the tensor tympani muscle; its inner wall by the carotid canals; and the outer wall by the spinous process of the sphenoid bone, and foramen spinosum for the middle meningeal. Two large arteries lie close beside the upper wall of the osseous tube, which is a thin bony plate forming part of the middle fossa of the

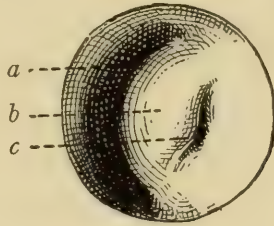


FIG. 155.—Pharyngeal Orifice of the Right Eustachian Tube at Rest. (View through a Eustachian salpingoscope. The fossa of Rosenmüller is seen on the left because the lenses reverse the image. *a*, fossa of Rosenmüller; *b*, torus tubæ; *c*, mouth of tube, closed.)

skull, and supporting the temporo-sphenoidal lobe. The lower wall of the tube is the base of the inner half of the vaginal process of the petrous bone. The anterior wall is the posterior wall of the glenoid fossa. Its posterior wall is very thin; superiorly it is formed by the *canalis pro musculo tensore tympani*, and below by the anterior wall of the bend of the *carotid canal*.

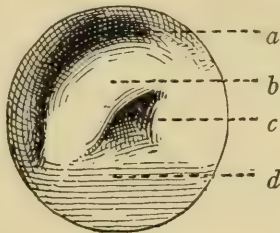


FIG. 156.—The same pharyngeal orifice of a Eustachian tube as in Fig. 6 during an act of swallowing. The upper surface of the soft palate occupies the foreground. The fossa of Rosenmüller is nearly closed by the backward and upward movement of the alar cartilage which has distended the tube. *a*, Fossa of Rosenmüller; *b*, torus tubæ; *c*, mouth of tube, opened; *d*, soft palate.

The *cartilaginous portion* of the tube has for its posterior wall a plate of cartilage which has a nearly right-triangular posterior surface, and forms the greater part of the anterior wall of the *fossa of Rosenmüller* or *pharyngeal sinus*. The apex of this triangle of cartilage lies at the junction of the cartilaginous with the osseous tube. The upper border of the cartilage is attached to the skull and fits into a depression on the sphenoid bone. The right angle

of the triangle is situated at the pharyngeal end of the upper border of the cartilage, and is attached to the skull near the base of the inner pterygoid process. The inner border of the cartilage forms the short limb or vertical side of the triangle. The cartilage projects into the pharynx and is called the *torus tubæ*. This border is also the free border of the cartilage and marks the pharyngeal entrance of the tube. The lower extremity of the free border ends in the *angular process* of the cartilage. The third and lower side of the triangle is freely movable. This *triangular* or *alar cartilage* passes above the tube and forms the *hamular process*, which turns down in front, and forms a small part of the anterior wall of the tube. The cartilage, which is made up of one large and several accessory plates, is elastic and contains clefts and holes. The greater part of the *anterior wall* of the tube is composed of strong membrane.

The inferior wall of the open tube is a loose elastic sheet of fibrous tissue which contracts and folds together when the tube is closed. The lumen of the inner third of the tube is obliterated by the contact of the anterior and posterior surfaces when the tube is closed. The upper and lower boundaries of the external half of the cartilaginous tube are formed by the concavity of the alar cartilage. This part of the tube always remains open because the anterior wall does not wholly collapse against the concave posterior wall. The outer part of the tube, which normally is open, has a rigid and comparatively non-elastic wall, while the pharyngeal end is collapsible. When the tube is closed, the mucous membrane lies in longitudinal folds and forms reduplications or *rugæ*, especially toward the pharynx and floor of the tube; but, when the tube is dilated, these *rugæ* almost entirely disappear. The pharyngeal end of the tubal mucosa is thicker and richer in glandular structures and lymphoid follicles than the rest of the tube. The long diameter of the closed pharyngeal ostium measures, on an average 7 mm.; the open ostium, an equilateral triangle, about 6 mm. (See Figs. 155 and 156 of pharyngeal mouth of tube.)

Several muscles are situated on or in the neighborhood of the pharyngeal tube and affect it by their contractions. Chief of these are the *retrahens tubæ* or *levator palati* and the *tensor tympani*. The fibers of both of these muscles run almost parallel to the long axis of the tube. The levator lies below the lumen of the tube and anterior to the angular process of the alar cartilage. It is attached

peripherally to the base of the skull on the petrous bone close to the entrance of the carotid canal. Sometimes the fibers are attached to the lower border of the alar cartilage.

The *tensor palati* is a thin muscular and aponeurotic sheet, covering the anterior surface of the tube. It arises in a broad band from the sphenoid bone close to the outer side of the attachment of the cartilage of the tube. The direction of the muscular fibers varies from absolute parallelism with the tube to an angle of 10° with it.

The *fossa of Rosenmüller*, or the *pharyngeal sinus*, lies behind the tube in the superior posterior angle of the naso-pharynx. It is lined by the mucous membrane of the pharynx and is rich in lymphoid

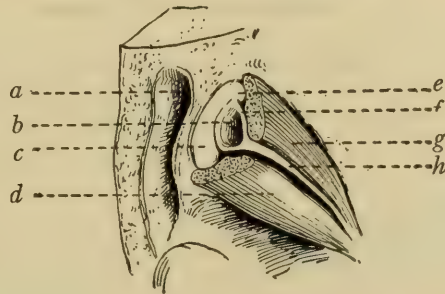


FIG. 157.—Shows the tube in cross-section. Two mm. of the pharyngeal extremity have been removed. The fibers of both the tensor and levator muscles are seen running parallel to the tube and are separated by the salpingo-pharyngeal fascia. The levator palati is seen resting on the anterior surface of the angular process of the cartilage. The levator palati has been drawn tense in the backward direction which it occupies when the soft palate is raised. It pushes the angular process of the cartilage upward and backward, encroaches upon the lumen of the fossa of Rosenmüller, and opens the tube. The anterior wall of the tube remains fixed. The increased circumference of the open tube is furnished by the elasticity of the tubal wall between the cartilage and the attachment of the salpingo-pharyngeal fascia. *a*, Fossa of Rosenmüller; *b*, section of tube, opened; *c*, cartilaginous portion of tube; *d*, levator palati; *e*, hamular process of cartilage; *f*, membranous portion of tube; *g*, tensor palati; *h*, fascia between tensor and levator palati.

tissue. It furnishes room for the movements of the alar cartilage which lies in its anterior wall. The cross-section of the fossa is somewhat lenticular in shape. Its upper angle is formed by the angle of attachment of the alar cartilage of the Eustachian tube to the base of the skull. Its lower commissure is formed by the upper border of the *superior constrictor* of the pharynx, or by the angle between the two slips of this muscle. The apex of the fossa reaches nearly to the *lower orifice* of the *carotid canal*. The posterior wall is supported by the prevertebral muscles. The depth of the fossa, measured along its anterior wall, is on the average 18 mm.

The distance from the upper to the lower commissure averages 26 mm. When the Eustachian tube is closed, the width of the sinus averages 11 mm.

The *cavum tympani*, or middle ear proper, is a disk-shaped space, inclined at 45° to the anteroposterior, sagittal, and horizontal axes of the head, and is larger in its wide diameters than the external auditory canal. It is divided into two compartments, the *atrium* or drum proper, and the *epi-tympanum* or *attic*. It contains the little ear-bones or *ossicles*, their muscles, tendons, and ligaments; the facial and the *chorda tympani* nerve, and numerous reduplications of mucous membrane. The walls of the cavum contain several

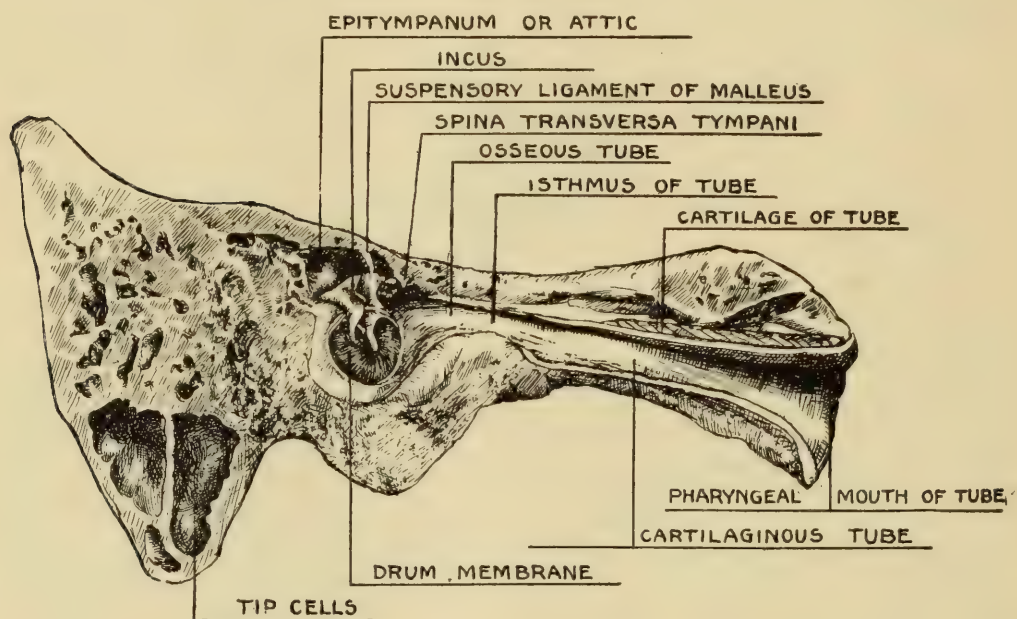


FIG. 158.—Outer Half of Vertical Section of Middle Ear Tract Through Mastoid Antrum and Eustachian Tube.

organs of especial importance and are of interest for many reasons. The walls are covered by a thin mucous membrane, or mucoperiosteum, which is continuous with the mucosa of the tympanopharyngeal tube. This membrane continues backward into the mastoid antrum and cells. The epithelium is columnar and ciliated in the lower part of the tympanum and flatter in the upper part. The mucous lining contains glandular elements which are more numerous in the anterior part, and disappear gradually posteriorly.

The outer wall of the cavum is made up of the *drum membrane* or drum head with its bony frame, and the outer wall of the attic.

The *drum head*, or *membrana tympani*, lies obliquely and leans forward, outward, and downward at an angle of 45° , forming the upper posterior surface of the inner end of the external auditory

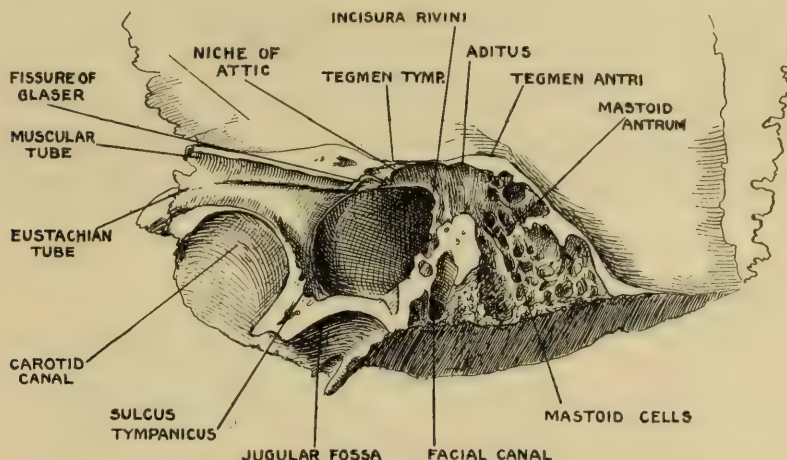


FIG. 159.—Vertical Section through Middle Ears shows Outer Wall of Cavum Tympani.

canal. It is a tense, rigid, highly elastic membrane with an outward convexity. This convexity, however, is changed to a concavity at the center where the membrane is attached to the end of the *handle*

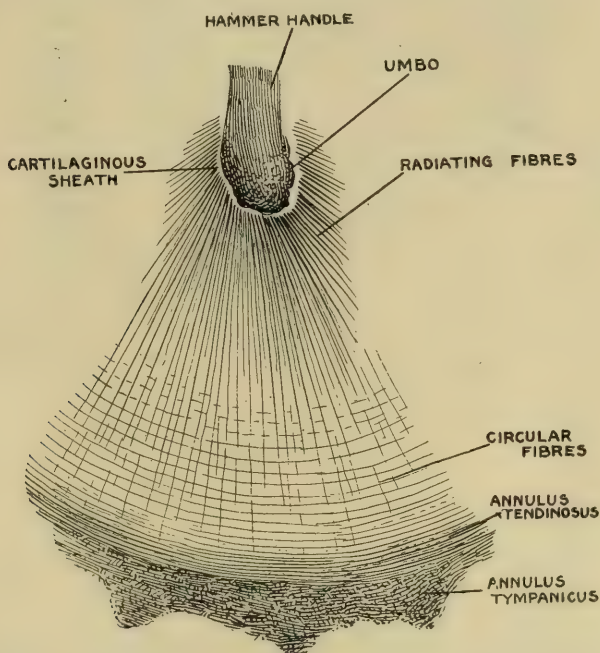


FIG. 160.—Diagram of Fibers of Membrana Propria of the Drum Membrane

of the *hammer* or the manubrium of the malleus. At this point there is an *umbilical depression*, the umbo. The membrane lies flat along its attachment to the rest of the hammer handle. The

membrana tympani is made up of three layers, the outer dermoid layer being continuous with the lining of the external auditory canal. This layer contains blood-vessels and nerves and is covered by a layer of flat epithelium with a deeper layer of cylindrical cells. The inner, or mucous layer, is continuous with the mucous lining of the cavum tympani. It is covered with simple cuboid epithelium.

The middle layer, or *membrana propria*, is composed of two sets of connective tissue fibers with very few elastic fibers, one set radiat-

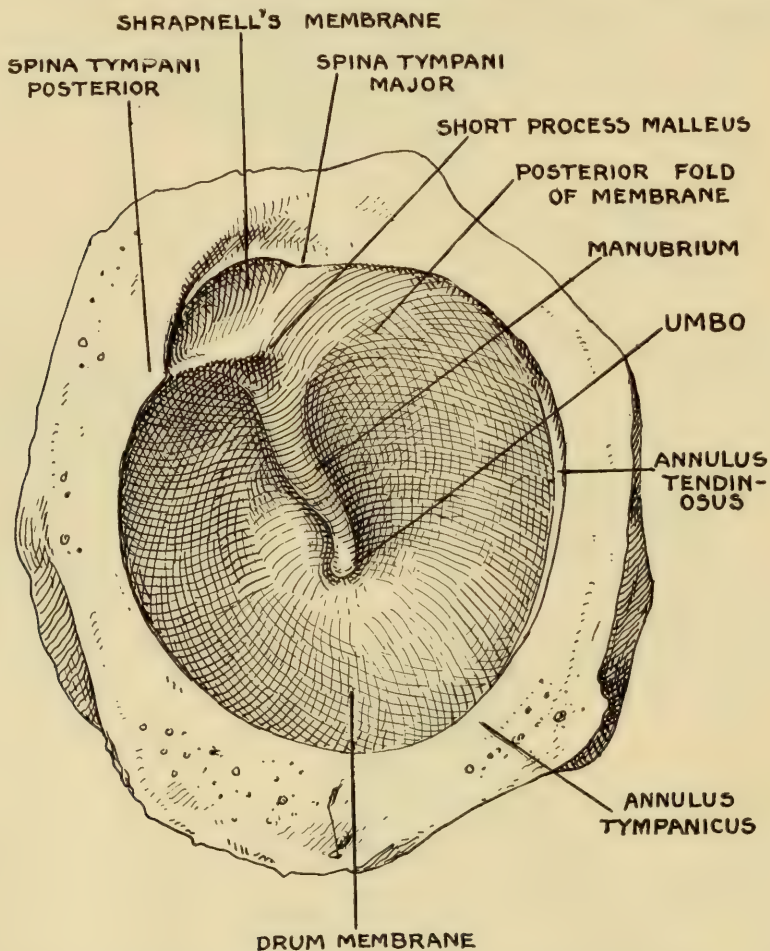


FIG. 161.—Outer Surface of Left Drum Membrane (Enlarged).

ing from the umbo and one concentric. The radiating fibers form the outer layer and are most abundant at the umbo, while the fibers of the concentric or inner layer are most abundant near the periphery of the membrane. The fibrous layer of the drum head is not of even thickness or strength. It is thinnest and weakest in its upper posterior quadrant and is altogether wanting in a small area at the upper margin of the drum head. This area is called

Shrapnell's membrane, or *membrana flaccida*, in contrast with the rest of the drum membrane which is called *vibrans*. The *membrana vibrans* is attached peripherally to the *annulus tendinosus* or tendinous ring, which is itself fastened in the *sulcus tympanicus* of the bony *tympanic ring* or *annulus tympanicus*, forming the support or frame for the drum head. The drum membrane is attached by its *membrana propria* to a cartilaginous sheath which covers the anterior surface of the handle of the hammer.

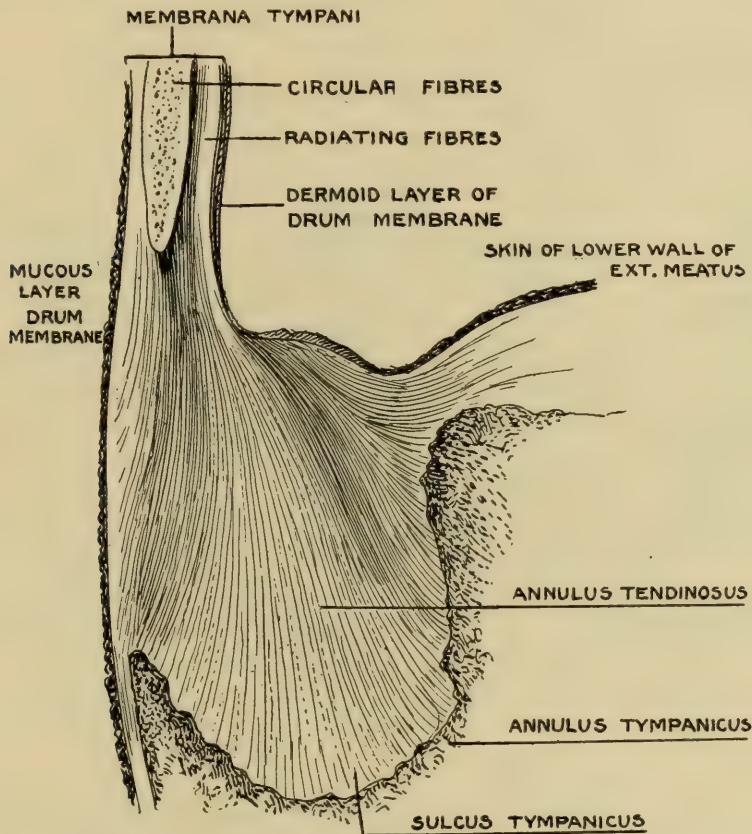


FIG. 162.—Section of Attachment of Drum Membrane to the Sulcus Tympanicus (enlarged).

The outer surface of the drum head shows the *membrana vibrans* attached to the outer surface of the handle of the hammer from the umbo where the membrane is attached to the tip of the handle, up to the short process of the hammer at the base of the handle. The *short process* of the hammer forms a slight protuberance on the surface of the membrane. From the end of the short process of the hammer, two faintly marked lines and two folds radiate in the membrane. The two lines lie above and are formed by small bands of fibrous tissue called *Prussack's fibers*, which run to the

anterior and posterior extremities of the annulus tympanicus. These extremities are the anterior and posterior edges of a rounded notch, the *incisura Rivini*. The fibers and the notch enclose the flaccid or Shrapnell's membrane. The two folds, called the *anterior* and *posterior folds* of the drum membrane, lie lower, one passing forward and one backward. They indicate a line of transition in the curve of the surface of the drum membrane between the vibrating and non-vibrating membranes.

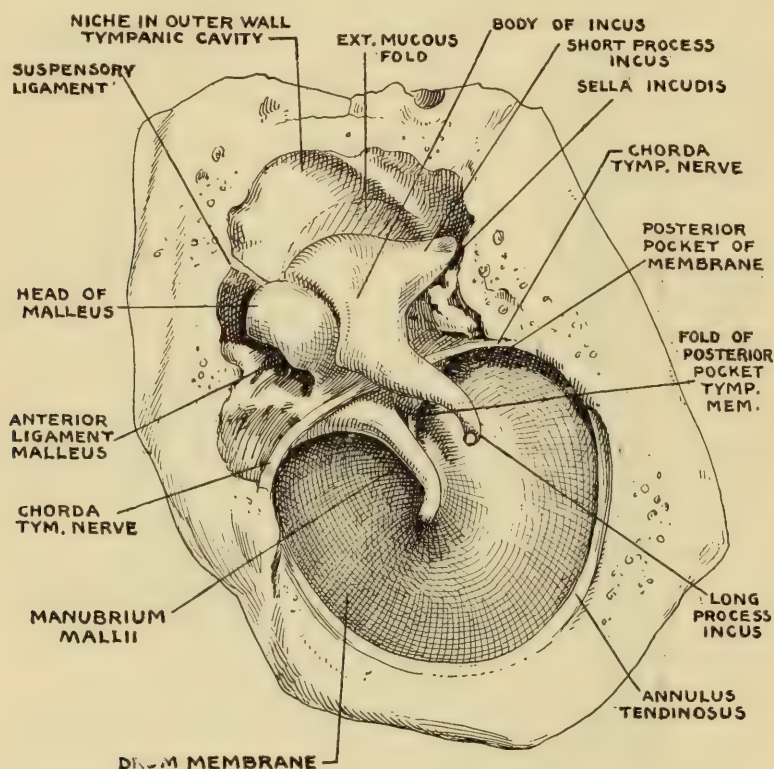


FIG. 163.—Inner Surface of Right Drum Membrane and Outer Wall of Attic (enlarged).

The inner surface of the drum membrane shows the vibrating membrane with the handle of the hammer in bold relief. From the inner edge of the upper half of the posterior surface of the hammer handle, a web of membrane loops backward to be attached to the annulus tendinosus. Between this fold of membrane and the membrana vibrans lies the *posterior pocket* of the drum head. The apex of the pocket may be closed or open. If open, it connects with *Prussack's space*. A smaller fold of membrane extends from the upper end of the inner edge of the anterior surface of the handle, and runs along the lower surface of the *anterior ligament* of the ham-

mer. Between this fold and the *membrana vibrans* a shallow pocket is formed which is called the *anterior pocket* of the drum membrane. This may also open superiorly.

The nerve known as the *chorda tympani* is plainly seen crossing the tympanum. This nerve on its way forward emerges from its canal at the inner side of the *sulcus tympanicus* and forms the free edge of the posterior half of the fold of the posterior pocket. It then crosses the inner side of the neck of the hammer and disappears in its foramen of exit in the fissure of Glaser.

The outer bony wall of the *cavum tympani* is continuous below

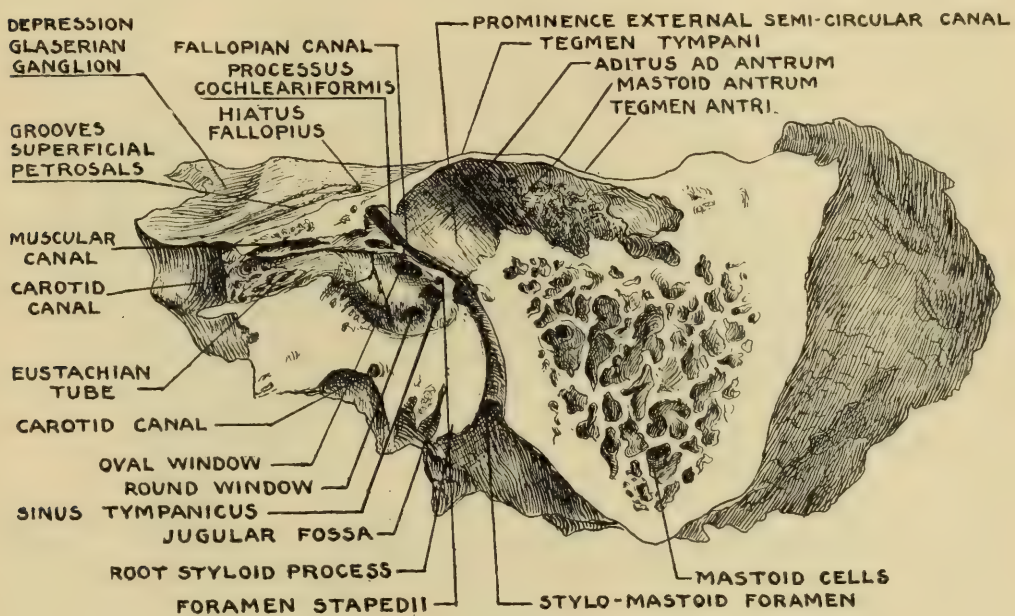


FIG. 164.—Inner Wall of Left Middle Ear Tract, Vertical Section of Temporal Bone.

with the floor; above, this wall bulges outward and forms a small shelf which overhangs the inner end of the external auditory canal, and is called the *niche of the attic* or *epitympanum*. Above this niche the outer wall joins the upper wall or tegmen of the *cavum* which is also the upper wall of the attic. In the center of the upper part of the tympanic margin of the outer wall of the *cavum* there is a little indentation in the floor of the niche of the attic called the *incisura Rivini*. In front, the outer bony wall of the *cavum* joins the anterior bony wall of the *osseous tympano-pharyngeal tube*. The posterior part of the outer bony ring of the *cavum* is continuous below with the posterior osseous wall of the *cavum*. Its upper half forms the outer wall of the *aditus ad antrum mastoideum*. At

this point the bony wall bends abruptly outward, running nearly parallel to the external auditory canal and forms the anterior wall of the *antrum mastoideum*.

The *internal wall* of the *cavum tympani* is a bony barrier between the middle ear and the labyrinth or internal ear. The lower half of this wall forms the inner wall of the atrium and is occupied by a bony eminence, the *promontory*, which is formed by the bony capsule of the *first turn* of the *cochlea*. Above and behind this eminence there is a depression, the *pelvis* of the *oval window*. At the bottom of the *pelvis* is an opening, the *fenestra ovalis*, which leads from

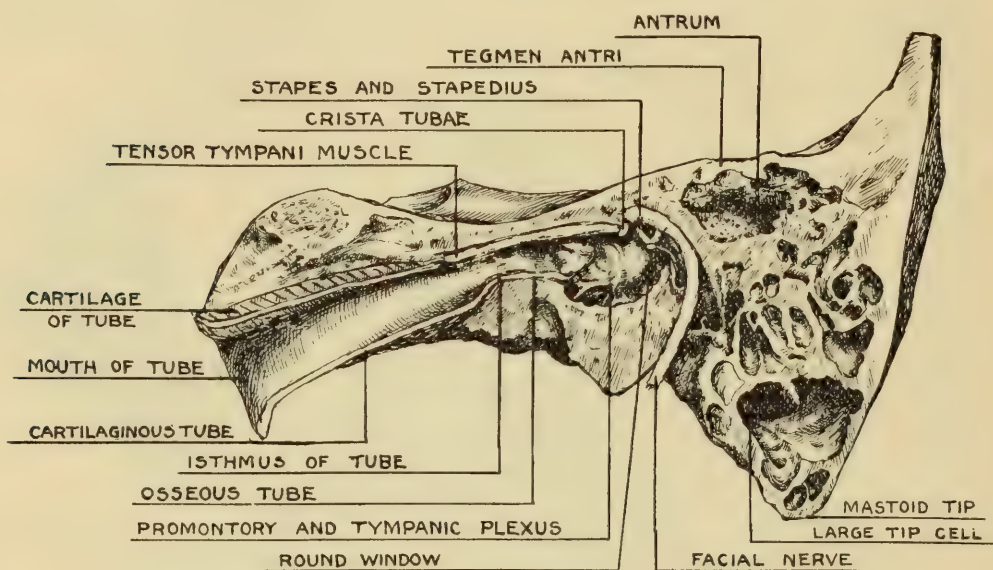


FIG. 165.—Inner Wall of Middle Ear Tract, from Eustachian Tube and Mastoid Antrum.

the *cavum* into the *vestibule* of the labyrinth. The *foot plate* of the *stapes* articulates by an orbicular ligament with the edges of this window. Below the oval window and behind the promontory there is a depression leading inward, forward and upward, the *pelvis* of the *round window*. This opens through the round window, *fenestra rotunda*, into the base of the *scala tympani* of the first turn of the *cochlea*. The *membrana tympani secundaria* closes the round window. Up and down the face of the promontory there are tiny *grooves* and *foramina* for the *tympanic plexus* of nerves and vessels. Below and behind the promontory the inner wall of the *cavum* becomes very rough with bony *spiculæ* and *trabeculæ*, which form small cells. The largest of these cells, which lies near the round window, is called the *sinus tympanicus*. Near the

posterior lip of the oval pelvis there is a tiny pyramid perforated like a hollow needle or snake's fang. This is the *processus perforatus* for the passage of the tendon of the *musculus stapedius*. Above and in front of the oval pelvis there is a small curved bony lamella, the *crista tubæ* or *rostrum cochleæ*. Connected with the posterior end of a thin lamella of bone is the *processus cochleariformis*, or *septum tubæ*. This lamella of bone extends forward, parallel to the tympano-pharyngeal tube, forming a closed canal for the *musculus*

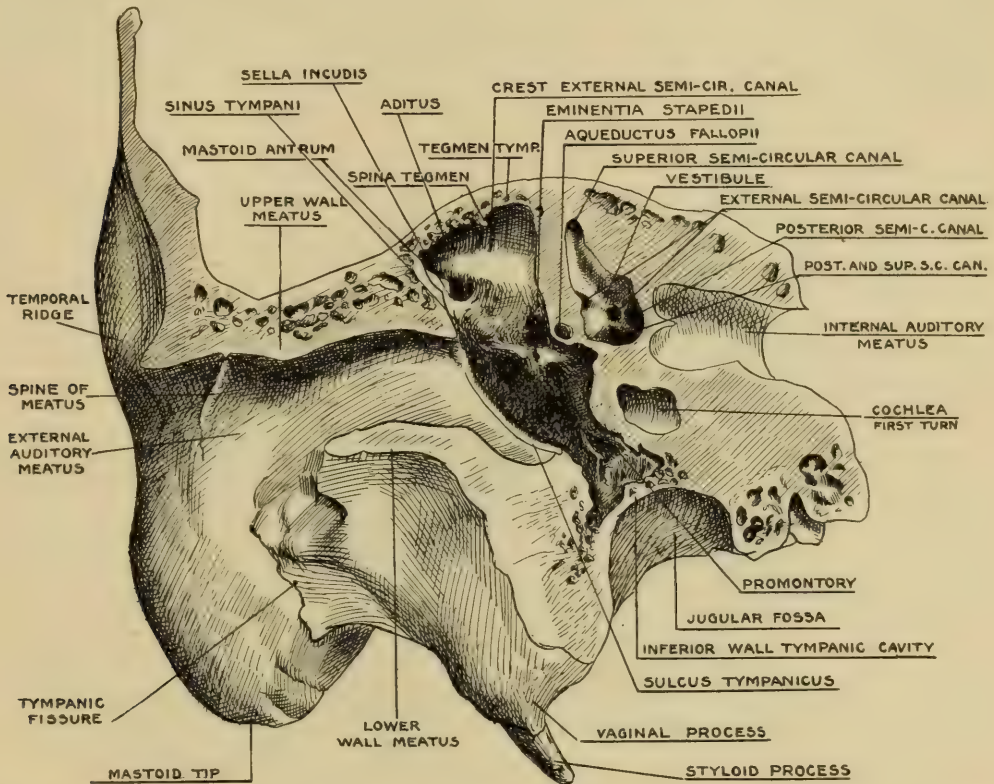


FIG. 166.—Posterior Half of Vertical Section of Right Temporal Bone through the External and Internal Meati, showing Posterior Tympanic Wall (enlarged).

tensor tympani. The tendon of the *musculus tensor tympani* turns outward at a right angle at the *crista tubæ* to reach its attachment on the handle of the hammer. Along the upper edge of the oval pelvis there is an elongated rounded ridge, the *Fallopian eminence*, formed by the canal of the *facial nerve* or *aqueduct of Fallopius*. The bony wall of the canal is sometimes partially deficient at this point. At the upper margin the inner wall of the *cavum* passes into the *tegmen tympani*. Posteriorly, the lower half of the inner wall passes into the posterior wall of the *cavum*, and the upper half passes

into the inner wall of the *aditus ad antrum*. Anteriorly, the inner wall of the cavum forms the outer wall of the *cochlea* and passes into the anterior wall of the cavum below, and the inner wall of the *tympano-pharyngeal tube* above. The line of demarcation on the inner wall of the cavum between the atrium and epitympanum runs from the *cristæ tubæ* along the lower margin of the oval window to the lower lip of the *aditus ad antrum*.

The *superior wall* of the cavum, called the *tegmen tympani*, is a thin lamella of bone which may be deficient in part. It separates the middle fossa of the skull from the cavum and supports the *temporo-sphenoidal lobe* of the cerebrum. Its upper surface shows

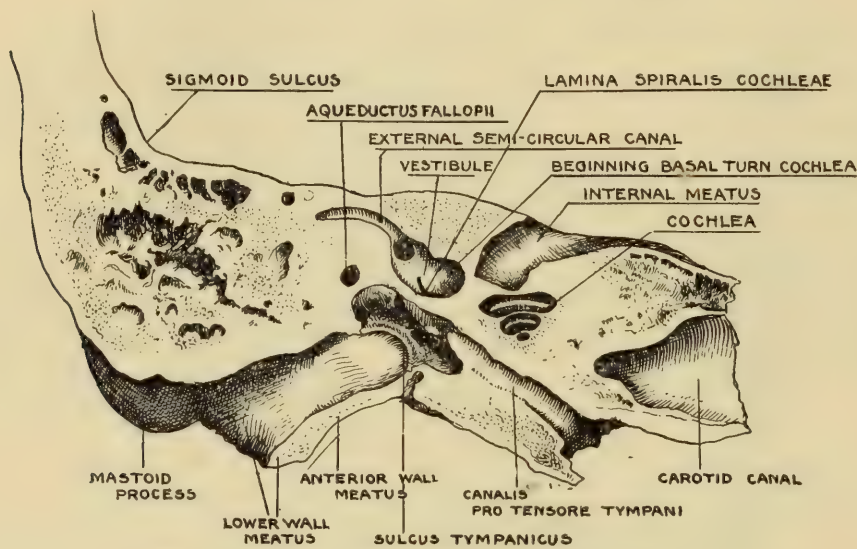


FIG. 167.—Lower Half of Horizontal Section of Right Temporal Bone, cut through. External Auditory Meati showing the Lower Tympanic Wall.

marks of the cerebral convolutions. In young specimens the line of the petro-squamosal suture runs parallel to the squamous portion of the temporal bone. On the under surface of the tegmen this suture is indicated by a ridge, the *spina tegmenis mastoidei*, which ends in the *crista tegmenis* in front, from which the *suspensory ligament* of the hammer hangs. The rest of this surface is slightly trabeculated. Posteriorly the *tegmen tympani* is continuous with the *tegmen antri*. Anteriorly, the *tegmen tympani* is continuous with the roof of the *tympano-pharyngeal tube*. Just before the *tegmen tympani* reaches the tube, it has a small transverse ridge, the *spina transversa tympani*, from which hangs a membranous curtain enclosing the anterior chamber of the epitympanum. Externally,

the tegmen tympani passes into the wall of the niche of the attic. Along the outer border the tegmen may have openings communicating with cells, which extend over the osseous part of the external auditory meatus and up into the squama and into the zygomatic roots.

The *posterior wall* of the cavum is somewhat trabeculated below. The cavum is separated from the jugular fossa by a plate of bone, which may be very thin and dehiscent. Above, the wall opens into the aditus ad antrum, forming its floor. On the lower anterior edge of this opening there is a small shelf or *cella incudis* for articulation with the *short process* of the *anvil*.

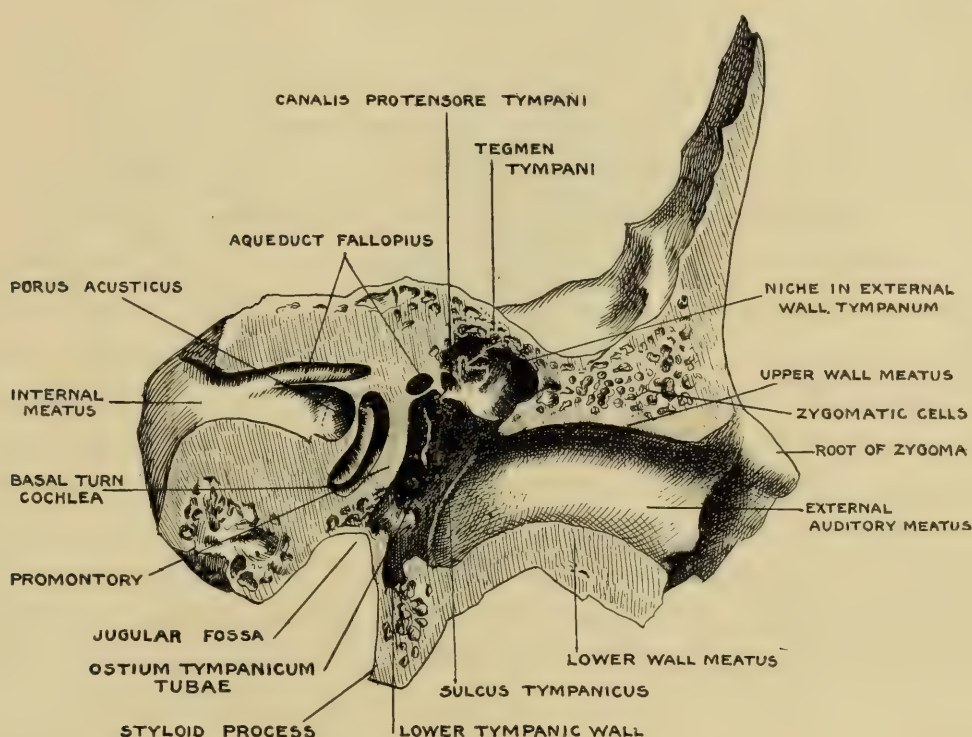


FIG. 168.—Anterior Half of Vertical Section of Right Temporal Bone, cut through the External and Internal Auditory Meati, Showing the Anterior Tympanic Wall (enlarged).

The *inferior wall* of the cavum is more or less trabeculated. Posteriorly it is separated from the jugular fossa by a plate of bone which, in many specimens, is very thin and sometimes deficient. Anteriorly the inferior wall is separated from the *knee* of the *carotid canal* by a very thin plate of bone, which may also be deficient in part.

The lower portion of the *anterior wall* is somewhat trabeculated. The bone covering the knee of the carotid canal may be very thin

and perforated. This wall continues above to form the lower margin of the tympanic mouth of the tympano-pharyngeal tube.

In pneumatic temporal bones, those with extensively developed systems of air cells, the trabeculated area of the cavum may communicate with variously extensive series of pneumatic cells in the neighboring portion of the bone.

The *attic* or epitympanic part of the cavum tympani forms an intermediate chamber between the atrium or drum proper (that portion of the cavum which is in immediate relation with the drum membrane) and the *mastoid antrum*. It is separated from the drum proper by the short process of the hammer, the articulation of the hammer and anvil, the tendon of the tensor tympani, the processus pro musculo tensore tympani, the long process of the anvil, the lower lip of the oval window, and the mucous membrane folds extending across this area. An almost horizontal plane of demarcation between the drum cavity proper and the attic is formed, but the division is oblique to the axis of the cavum. The passageway between the epitympanum and atrium is blocked by the ossicles, their tendons and ligaments, and also by mucous membrane folds. The passage varies in size and position, depending upon the amount of mucous membrane reduplication. There may be no more than a few pin-hole communications, or there may be wide spaces surrounding the major ossicles. The passage most frequently open lies between the short process of the anvil and the outer wall of the attic. The attic contains all of the ossicles except the handle of the hammer and opens posteriorly through the aditus ad antrum or passage into the antrum. The atrium opens anteriorly into the tympano-pharyngeal tube.

The *mastoid antrum* is a chamber of variable size which leads backward and outward from the epitympanum, or upper part of the cavum, through the aditus ad antrum. Its length, measured from the tip of the short process of the incus, is on an average, 11 mm. At the posterior part of the floor of the aditus and adjacent antrum, there is a slightly rounded longitudinal elevation which is the bony capsule of the external or horizontal semicircular canal, and is called the *eminencia canaliculi externi*. The walls of the antrum are extensively trabeculated and covered with mucous membrane continuous with the lining of the epitympanum. The mucous membrane also forms trabeculæ, supplementing the osseous laby-

rinth, thus nearly filling up the antrum with cells. The axis of the antrum is continuous with the axis of the tympano-pharyngeal tube and extends outward and backward almost parallel to the posterior wall of the external auditory canal. The anterior wall of the antrum is the posterior superior wall of the canal. The trabeculae of the antrum form air cells of a more or less complicated and extensive system. The roof of the antrum is called the tegmen antri; it is the backward continuation of the tegmen tympani, and has the same intracranial relations. The posterior wall of the antrum comes into relation with the *sigmoid sinus* and the posterior

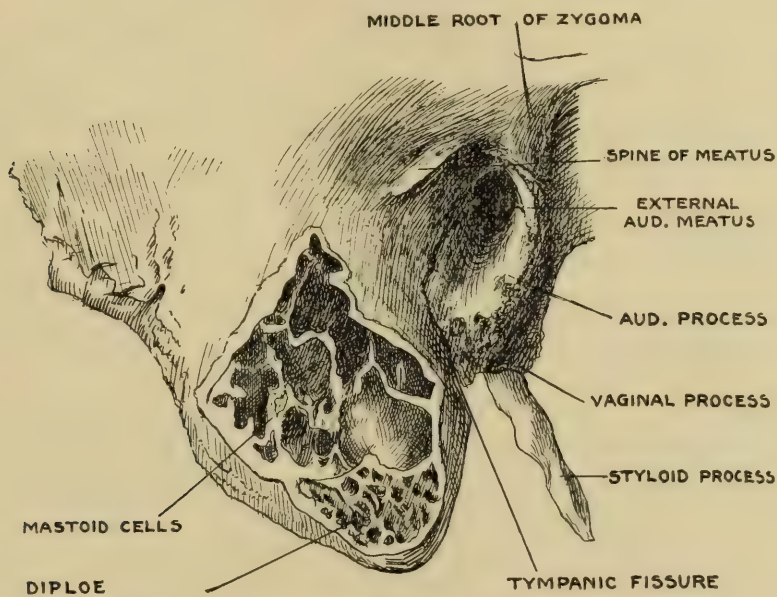


FIG. 169.—Mastoid Right Process with Outer Table Removed, Showing Large Cells at base of Process and Diploe at Tip.

cranial fossa. The internal wall of the antrum is formed by the part of the osseous labyrinth called the *solid angle*, which lies between the semicircular canals. In the cases where the sigmoid sinus approaches close to the posterior wall of the external auditory canal, the sinus passes externally to the antrum and the bony groove for the sinus forms the outer wall of the antrum. As a rule, however, the outer wall of the antrum, like the inferior wall, is made up of pneumatic cells of the mastoid process.

The mastoid cell system is extremely variable in extent and in the arrangement of the cells. Although usually limited in extent to the mastoid process, in some instances the cells, besides occupying the whole mastoid process, extend inward to the apex of the petrous

bone along its three surfaces; upward in the squama to the parietal bone; forward into the zygoma and to the sphenoid articulation; backward into the occipital bone; downward and inward toward the jugular fossa and through the occipital bone to the foramen magnum, and into the jugular process of the occipital bone, which forms the posterior wall of the jugular fossa and of the foramen lacerum posterium. At other times the cells are wanting. The cells may be small, medium, or large, or there may be a combination of cells of various sizes. The structure of the mastoid process is not always pneumatic or cellular; it may be made up in whole or in part of diploic bone, or of very hard eburnated bone. The cells are most persistent near the antrum. The outer walls or cortex of the mastoid portion of the temporal bone vary in thickness in different specimens, and even in different parts of the same specimen, and are occasionally dehiscent in part. As a rule, the *tegmen mastoideum* is the thinnest mastoid wall. Sometimes cells approach very closely to the outer surface, to the inner surface or digastric aspect of the tip of the process, or to the internal surface along the groove for the sigmoid sinus. The walls may be deficient in any of these localities.

The *tympanic contents* are the ossicular chain, muscles, tendons, ligaments, the reduplications of the mucous lining, and the facial and the chorda tympani nerves. The ossicular chain is made up of three minute bones: the hammer or *malleus*, anvil or *incus*, and the stirrup or *stapes*. These form a chain connecting the drum head with the oval window. The hammer is attached to the drum head; the stirrup is fastened in the oval window, and the anvil connects the other two bones and rests on the floor of the aditus ad antrum. The handle of the hammer is attached to the drum head by the outer surface of a cartilaginous sheath. A strong *anterior ligament* attaches the neck of the malleus and its *processus gracilis* to the *crista tympani major* of the annulus tympanicus. The *processus gracilis*, together with the fibers of the anterior ligament, extends some distance along the fissure of Glaser. The upper part of the head of the malleus is connected with the tegmen tympani by a small *suspensory ligament* running from the *crista tegmeni*, the anterior end of the *spina tegmenis mastoidei*. The hammer has a weak *external ligament* extending from its neck to the border of the notch or *incisura Rivini*. There is also an internal ligament of the malleus

in connection with the sheath of the tensor tympani tendons. Prussack's space is a small chamber lying externally to the neck of the malleus, bounded on the outer side by Shrapnell's membrane, below by the short process of the hammer, above by the external ligament of the hammer, and anteriorly and posteriorly by Prussack's fibers.

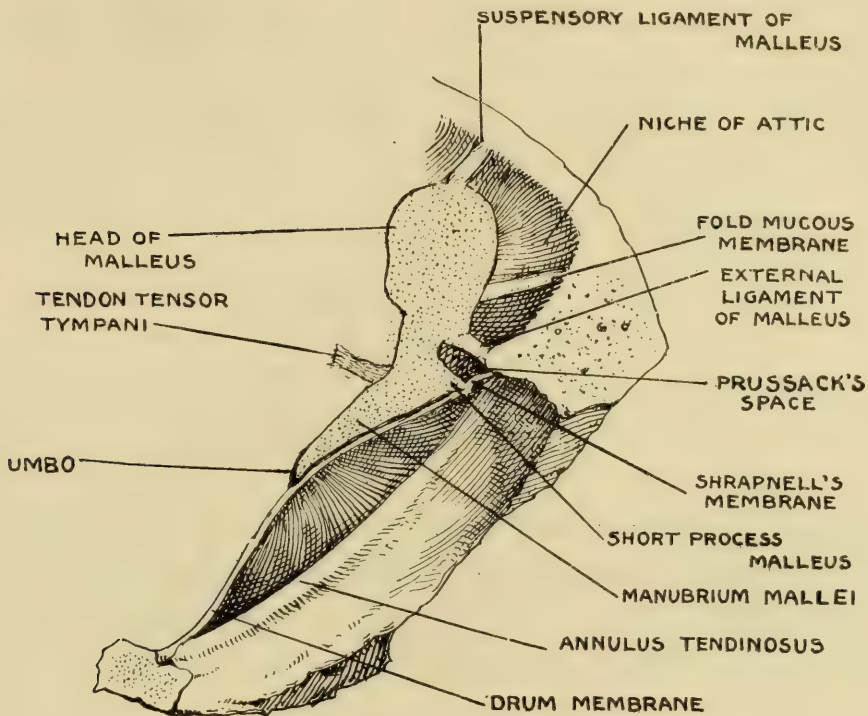


FIG. 170.—Longitudinal Section of Hammer, Cross-section of Attic, and Prussack's Space, Right Ear (enlarged).

The position of Prussack's space is such that fluid in the part of the attic which is external to the ossicles, tends to drain into it. The posterior surface of the head of the hammer articulates with the head of the incus by a true joint with two facets to correspond to the two *toothed processes* of the anvil. The anvil is supported at the aditus ad antrum by the tip of its short process resting on a synchondrosis and fastened by a double *fan ligament*. The *lenticular process* of the long process of the incus articulates with the head of the stapes by a true synovial joint. The stapes, a very small frail bone, articulates by the edge of its foot-plate with the orbicular ligament of the oval window. A synovial sac is found in this joint.

The right or left ossicle is easily distinguished. *Malleus*.—In

order to distinguish the right from the left malleus, the short process should be held toward you with the handle pointing down. When the bone is in this position, the side of the head which has the facet

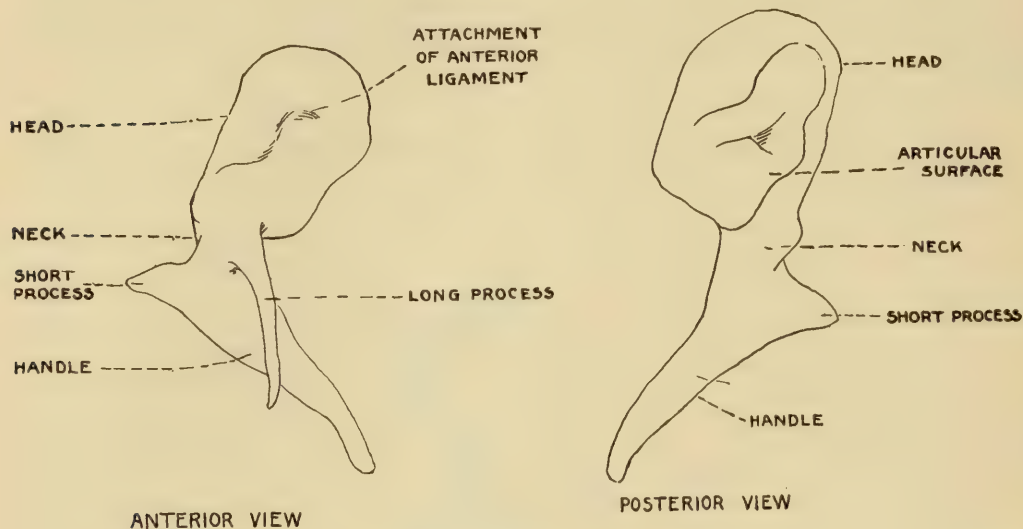


FIG. 171.—Malleus (enlarged).

is the posterior surface, and the surface with the short process is the external surface. In this way the bone is demonstrated as belonging to the right or left side. If the facet is toward your left hand, it is a right bone; if toward your right hand, a left bone.

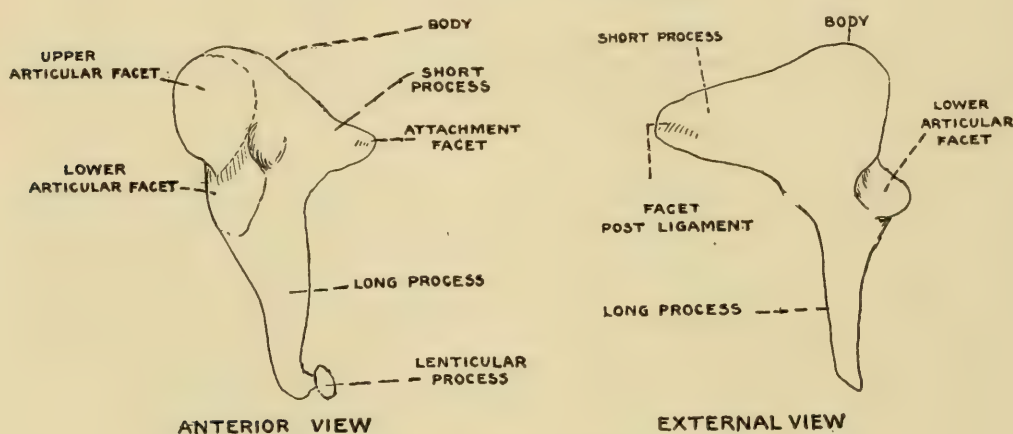


FIG. 172.—Incus (enlarged).

Incus.—To distinguish the right from the left, place the short process horizontally, the long process pointing down and the lower toothed facet facing you. As in the case of the malleus, the short process will point backward and determine the right or left bone.

If the short process is to your left, it is a right bone; if the short process is to your right, it is a left bone.

Stapes.—To distinguish the right from the left, place the bone with its head up and resting on the convex edge of the foot plate; then the more curved or heavier crus will be the posterior one and indicate a right or left bone in the same way as the malleus or incus

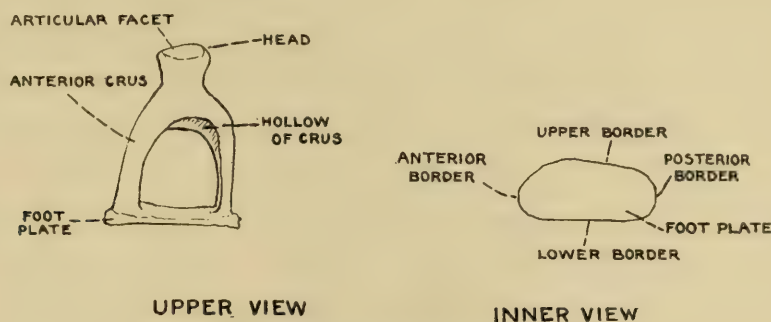


FIG. 173.—Stapes (enlarged).

were located. If this crus is to your right, it is a left bone, and if to the left, it is a right bone.

The tendon of the *musculus tensor tympani*, which is a comparatively strong muscle, passes outward from the crista tubæ on the inner wall of the cavum and is attached to the anterior border of the inner surface of the base of the handle of the hammer. The

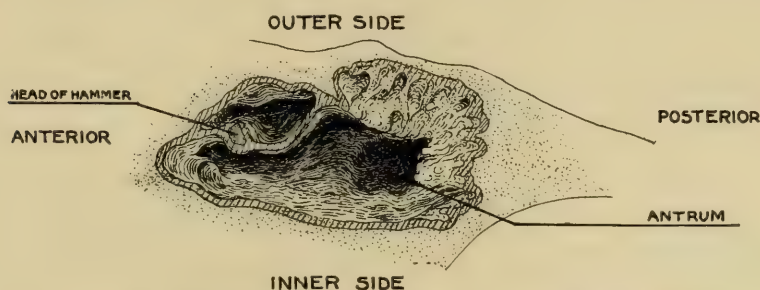


FIG. 174.—The right epitympanum and antrum of a child two years old exposed by removal of tegmina antri and tympani, viewed from above. The epitympanum and atrium are connected only by a pin hole on the inner anterior side of the head of the hammer. The incus is buried in mucous folds (enlarged).

tendon of the *musculus stapedius* passes forward from its tiny cana behind the oval pelvis and is attached to the posterior aspect of the head of the stapes.

There is, besides the chain of bones, their ligaments and tendons, a system of folds and reduplications of the mucous membrane which, when fully developed, separates the atrium from the epitympanum or

attic. These folds exist in normal tympana, but are somewhat irregular in their arrangement. When fully developed, the folds envelop all the ossicles except the handle of the hammer. These folds extend backward into the antrum, supplementing the true pneumatic cells by air cells of mucous membrane. As a rule, the folds are either vertical or horizontal. The vertical folds are parallel to the three long axes of the two larger bones; that is, they are parallel to the axis of the hammer and the axis of both the long and short process of the anvil. Sometimes also the folds are parallel to the tensor tympani tendon. The horizontal folds are parallel

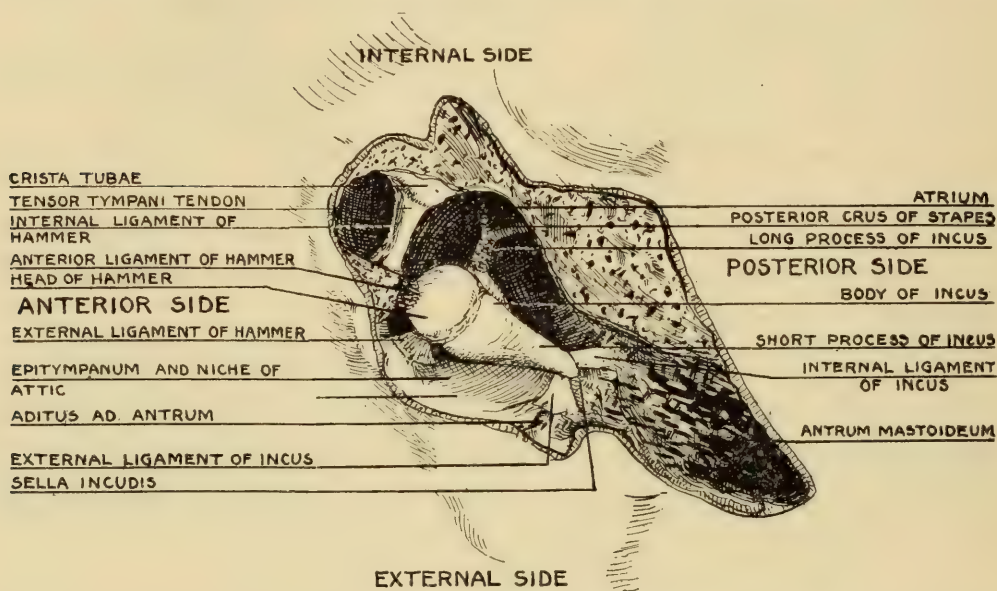


FIG. 175.—Adult Tympanum, Tegmen removed, showing minimum of mucous membrane reduplications (enlarged).

to the long axis of the anvil, and connect it with the inner, outer or upper walls of the tympanum. The mucous folds are especially abundant in the oval pelvis, extending in different directions from the stapes, as well as from the membrana propria of the stapes, which is a double sheet of mucous membrane enclosing an air space between the crura of the stapes. Most of the folds bind the crura of the stapes to the lower side of the oval pelvis.

The handle and short process of the hammer may be distinctly seen when the drum membrane is normal. The reflected light from the end of the long process of the anvil, the shadow of the round pelvis, and the reflected light from the convexity of the promontory can be clearly seen through a thin transparent membrane. When

the membrane is absent, inspection through the canal will, in most cases, disclose the inner wall of the cavum as far up as the oval window and the head of the hammer.

The *inner ear* is the *peripheral sound-perceiving apparatus* and the *peripheral space organ*. It contains the sensitive nerve endings for sound and for the cosmic senses of space and equilibrium. The inner ear is made up of a series of complicated canals in the hardest part of the petrous portion of the temporal bone, called the *labyrinthine capsule*. These canals are lined with a periosteal and serous membrane, or sero-periosteum, and are filled with lymph or serous fluid in which is suspended a membranous tube, called the *membranous labyrinth*. The *bony tube* comprises the *vestibule* or central chamber from which lead, posteriorly and superiorly, the three *semicircular canals* lying in the three planes of space and, anteriorly and inferiorly, the *cochlea* or snail shell. The *membranous labyrinth* is more complicated than the osseous labyrinth owing to certain constrictions and sacculations of its tube. The membranous labyrinth, surrounded by the osseous labyrinth, lies internally to the middle ear. Its position is readily located by the landmarks in the middle ear. The eminence of the *external or horizontal semicircular canal*, lying on the floor of the aditus ad antrum, is a landmark for the positions of the other two semicircular canals which lie at right angles to it; the posterior, behind and internal, and the superior, above and internal. The *oval window* indicates the vestibule into which it opens; the *round window* indicates the basal coil of the cochlea. From this point the coil of the cochlea runs forward and upward.

The *promontory* forms the outer wall of the cochlea, and the tympanic end of the inner wall of the tympano-pharyngeal tube forms the apex of the cochlea.

The *internal auditory meatus* is located at the base of the cochlea.

GENERAL EXTERNAL TOPOGRAPHY OF THE TEMPORAL BONE AND STRUCTURES SURROUNDING THE EAR.

Externally, the upper border of the *zygoma* gives a fixed line which can be used to locate anatomical relations by passing through it an imaginary horizontal plane. It indicates the level of the floor

of the middle cranial fossa and the summit of the tentorium cerebelli, which is attached to both lips of the groove for the lateral sinus from the knee of the sigmoid sinus backward. The posterior root of the zygoma forms the upper lip of the external osseous auditory canal and passes backward into the temporal ridge. The middle root forms the upper part of the anterior lip of the auditory canal. The anterior root forms the outer end of the articular eminence, which is the anterior boundary of the glenoid fossa.

A curved line, convex superiorly, drawn from the apex of the angle between the squamous and mastoid portions of the temporal bone to the superior occipital protuberance, indicates the course of the *lateral sinus*. The direction of the temporal ridge where it joins the posterior root of the zygoma indicates the direction of the descending limb of the *sigmoid sinus*. The apex of the angle between the squamous and mastoid portions of the temporal bone indicates the knee of the sigmoid sinus. Therefore, a line drawn through this point parallel to the lower end of the temporal ridge will indicate the location and direction of the descending limb of the sigmoid sinus. The level at which the sigmoid sinus turns inward to form its horizontal limb is indicated by the level of the bottom of the digastric groove, or the horizontal portion of the occipital bone. The distance between the knee of the sinus and the external osseous auditory canal is very variable; the sinus may impinge directly on the canal or lie some distance behind it.

The general outer contour of the mastoid region gives a very slight indication of the position of the sinus. In large, well-developed mastoids, it is usually placed far back; in small pointed mastoids, with sharply convex bases, it may be placed far forward. The *spine* of the *meatus* indicates the lip of the posterior superior wall of the external osseous auditory canal. An indefinitely marked line descending forward over the face of the mastoid process indicates the position of the *squamo-mastoidal suture*.

The inferior surface of the petrous pyramid presents the *stylo-mastoid foramen* and, just inside this orifice, is the entrance to the posterior canal of the *chorda tympani nerve*. This foramen serves for the exit of the facial nerve from the lower end of the *aqueduct of Fallopius* or *facial canal*. It is situated just behind the base of the styloid process, and at the anterior end of the digastric groove. Both the *styloid process* and the *digastric groove* are exceedingly

useful landmarks to indicate the position of the descending arm of the facial nerve. The digastric groove lies on the inner side of the base of the mastoid process and runs parallel to this surface of the process. It is filled by the posterior belly of the *digastric muscle*. A small secondary mastoid process is not infrequently seen lying internal to the digastric groove. It is usually pneumatic.

For convenience in description, the facial canal is divided into three parts: The *internal limb*, the *tympanic limb*, and the mastoid or *descending limb*. The course of the internal limb of the facia

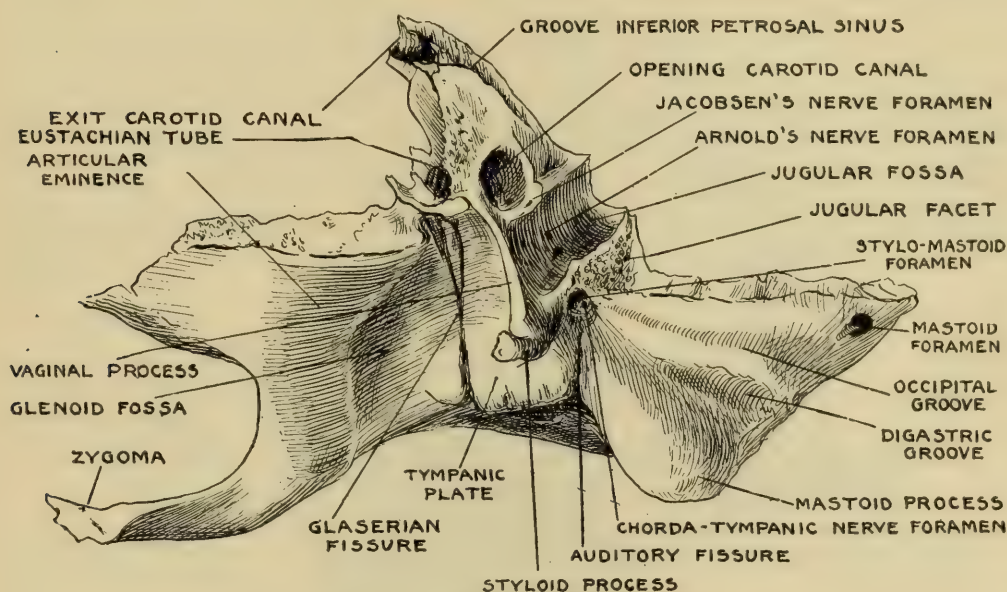


FIG. 176.—Under surface of Right Temporal Bone.

canal is directed outward from the upper internal quadrant of the internal auditory meatus to the hiatus of Fallopius. The hiatus of Fallopius is close to the inner wall of the cavum tympani, directly posterior to the crista tubæ and in front of the oval pelvis. At this point the facial canal turns backward at a right angle to form the tympanic limb of the aqueduct. The wall of the canal serves as the upper lip of the oval pelvis, and is known as the *Fallopian eminence*. The Fallopian canal, gradually curving downward to form the mastoid limb, passes below, in front and external, to the external semicircular canal, and, forming the lower lip of the aditus ad antrum, passes behind the posterior wall of the cavum. From there the course of the mastoid limb is almost vertically downward to the stylomastoid foramen; that is, the mastoid limb is inclined about 45° outward from the plane of the annulus tympanicus or

—leading to the facial canal. The posterior border of this surface or superior angle of the pyramid is grooved for the *superior petrosal sinus* which connects the *cavernous sinus* at the tip of the pyramid with the knee of the *sigmoid sinus*. This border also gives attachment for the tentorium cerebelli.

The *posterior surface* of the petrous pyramid rests against the lateral lobe of the cerebellum. The sigmoid sinus grooves the external inferior border of this surface. At the junction of the inner and middle thirds of this surface of the petrous bone is located the *internal auditory meatus*, through which the *facial*, the *intermediary*, and the cochlear and vestibular branches of the *auditory nerves* pass. Below the meatus lies the posterior opening of the *jugular bulb*, which opens horizontally forward from the inner end of the horizontal limb of the sigmoid sinus at right angles to this portion of the sinus and also at right angles to the axis of the

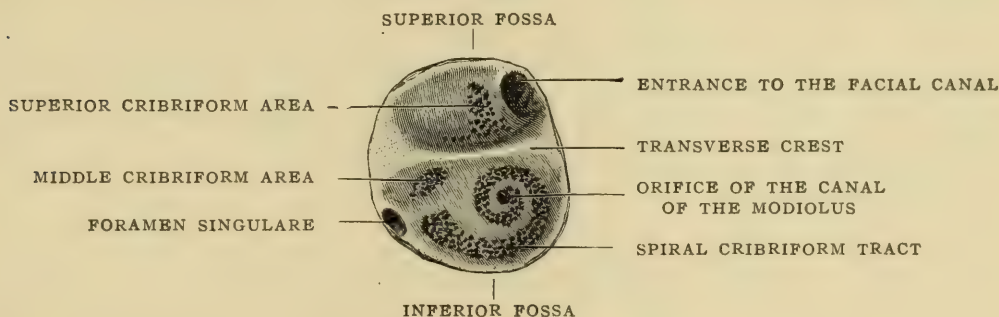


FIG. 178.—The Foramina in the Fundus of the Left Internal Auditory Meatus of a Child at Birth ($\frac{1}{4}$). Diagrammatic. (Morris.)

jugular bulb and vein. (These right angles make it impossible, in most cases, to curette the jugular bulb through the sigmoid sinus, or the sigmoid sinus through the jugular veins or bulb.) Along the inner third of the lower border of the posterior surface of the pyramid there is a shallow groove for the *inferior petrosal sinus*, which runs from the cavernous sinus in front outward, backward, and downward to the inner wall of the dome of the jugular bulb. Under the internal auditory meatus in the posterior inferior border of the petrous pyramid, there is a pyramidal depression for the entrance of the *aqueduct* of the *cochlea*. (External to this opening on the posterior pyramidal surface between the internal auditory meatus and sigmoid groove is the opening of the *aqueduct* of the *vestibule*.) Between the aqueduct and the groove for the sigmoid

sinus a slight elevation indicates the location of the posterior semi-circular canal. The third, fourth, fifth, sixth, seventh, eighth, ninth, tenth, and eleventh cranial nerves are in close relation to the posterior surface of the apex of the petrous pyramid.

The *deep cervical fascia* is attached to the base of the skull, lying beneath the platysma and surrounding the muscles and vessels of the neck. While it favors the passage of enclosed fluid downward to the thorax, it prevents passage of fluids backward among the vertebral muscles which are protected by the prevertebral fascia. The fasciæ of the region under consideration are important since they determine the course which pus may take after perforation of the cortex of the mastoid region. Perforation of the base or outer surface of the mastoid process leads to a subperiosteal abscess in the immediate neighborhood of the perforation. Perforation of the inner surface of the mastoid process or of the digastric fossa leads to a deep abscess in the neck with pus burrowing indefinitely downward to the mediastinum and pleural cavity. Perforation through the outer surface of the tip of the process allows the burrowing of pus within the sheath of the sternocleidomastoid muscle and cellulitis within the deep fascia of the neck.

BLOOD SUPPLY.

The ear has its chief blood supply from the external carotid artery through the posterior auricular, occipital, and temporal branches. Most of the auricle is supplied by the posterior auricular and occipital through perforating branches that come from the posterior auricular fossa. The helix, tragus, and lobe are supplied by the auriculo-temporal arteries from the superficial temporal in front of the ear, which anastomose with the posterior auricular.

External Auditory Canal.—The anterior wall of the cartilaginous canal is supplied by the anterior auricular artery, which passes between the bony canal and the cartilage. The posterior wall of the cartilaginous canal is supplied by the posterior auricular artery. The bony meatus derives its blood supply from the deep auricular branch of the internal maxillary artery.

The Drum Membrane.—The cutaneous layer of the drum membrane is supplied by the anterior manubrii mallei from the deep auricular; the malleolar artery passes through the annulus

tendinosus, follows along behind the manubrium and forms radial anastomoses. The mucous layer is supplied by the anterior temporal from the internal maxillary through the fissure of Glaser and anastomoses with the cutaneous supply.

Eustachian Tube.—The roof of the tube is supplied by a branch of the middle meningeal from the internal maxillary artery, called the superficial petrosal branch. The floor of the tube is supplied by the basilar branch of the ascending pharyngeal artery from the external carotid; also by the Vidian artery through the petrosquamosal fissure from the superior palatine, a branch of the middle meningeal. The descending palatine joins the ascending palatine branch of the facial artery and joins also the ascending pharyngeal branch of the external carotid.

The *mastoid process and cells* are supplied by mastoid branches of the stylomastoid artery. A branch of the facial artery anastomoses with the stylomastoid artery, from the Fallopian canal.

The *antrum and attic* are supplied by branches of the middle meningeal artery through the petrosquamosal suture.

The *tympanic cavity* is supplied anteriorly by the tympanic branch of the external carotid through carotido-tympanic canaliculi. The anterior ligament of the malleus is supplied by the anterior tympanic artery of the internal maxillary through the fissure of Glaser, and joins the stylomastoid artery in the drum head. The temporal artery may send a small branch through the fissure of Glaser. The tympanic branch of the internal maxillary artery anastomoses also with the tympanic branch of the internal carotid, the Vidian branches of the internal maxillary, the descending palatine, and the pharyngo-palatine, and sends small branches to the tympano-pharyngeal tube and its muscles. The posterior portion of the tympanic cavity is supplied by the posterior tympanic artery of the stylomastoid through the canal of the chorda tympani. The stapedius muscle is supplied by the stapedic artery and by branches of the stylomastoid artery in the Fallopian canal. The stylomastoid artery enters the foramen of the same name, together with the tympanic branch of the internal maxillary, and in the cavum joins branches of the superficial petrosal, a branch of the middle meningeal. The stapes receives its blood supply by the anastomosis of the stylomastoid with the superior petrosal artery, which enters through the petrosquamosal suture from the middle

meningeal, and anastomoses with the labyrinthine vessels. The superior petrosal supplies the hammer, anvil, and internal tympanic wall. The tensor tympani muscle is supplied by a branch of the middle meningeal through the hiatus of Fallopius.

The blood supply of the upper portion of the tympanic cavity is received from the superior tympanic branches of the middle meningeal and the superficial petrosal branch from the roof of the tympano-pharyngeal tube. The lower portion of the tympanic cavity is supplied by the inferior tympanic artery, a branch of the ascending pharyngeal through the canaliculi tympanici. The walls of the promontory and endosteum of the labyrinth are supplied by communicating branches of the internal auditory artery which pass through vascular perforations of the promontorial wall.

Labyrinth.—The osseous semicircular canals are supplied by the arteria subarcuata through the fossa subarcuata, the internal auditory artery, a branch of the basilar through the internal auditory meatus. The membranous semicircular canals—utricle and saccule—are supplied by the vestibular artery, a branch of the internal auditory, which also supplies the vestibular nerve. The blood supply of the cochlear nerve, spiral ganglia, osseous spiral lamella, scala vestibuli, periosteum of walls of scalæ and spiral ligament is derived from the cochlear artery, a branch of the internal auditory. The internal auditory artery follows the auditory nerve and ends in loops of the terminal vessels. Some blood supply also reaches the membranous labyrinth from the inner walls of the osseous labyrinth. The chief of these branches is given off from the stylo-mastoid artery as it passes through the stylomastoid canal. These branches supply the semicircular canals and cochlea. The internal carotid traverses the inner half of the petrous pyramid and comes into close relation with the cavum tympani and with the tympano-pharyngeal tube. The middle meningeal artery passes through the foramen spinosum at the outer side of the osseous Eustachian tube, and supplies the upper surface of the petrous pyramid and the inner surface of the squama.

VEINS.

The veins of the auricle empty into the superficial temporal and external jugular veins. The veins of the antrum and attic empty

into the posterior auricular vein and into the sigmoid sinus. The veins of the promontory and endostium of the labyrinth empty into the middle meningeal veins and deep auricular veins.

The veins of the labyrinth empty chiefly through the internal auditory veins accompanying the internal auditory artery, which empties into the inferior petrosal sinus. There are other direct connections with the neighboring venous sinuses, namely, the inferior and superior petrosal, the sigmoid, and the petrosquamosal sinuses. Blood from the vestibule and semicircular canals returns in part through the vena aquæduktorum vestibuli which empties into the inferior petrosal sinus. The blood from the cochlea is returned partly through the vena aqueducti cochlea into the bulb of the internal jugular vein. The labyrinthine veins communicate with the tympanic veins through the tympanic wall.

The venous system of the extracranial part of this region is very similar in its arrangement to that of the arterial system. The veins from the posterior part of the auditory canal and auricle empty into the mastoid and external jugular veins. These veins, draining the anterior part of the canal and auricle, empty into the temporal veins. The deeper veins may empty into the pterygoid plexus, and there may be more complicated anastomoses with the lingual, superior hyoid, and facial veins. The veins of the anterior wall of the Eustachian tube drain into a vein communicating with the cavernous sinus. There is an erectile venous plexus at the pharyngeal mouth of the tube which is continuous with the erectile system of the turbinals. Some of the veins from the tympano-pharyngeal tube flow into the internal jugular, and the anastomosis of the deep and superficial veins is complete. In the cavum, the communication of the arterioles and veins is direct, and the capillary system is very much reduced. Facts of importance are the free communication of the superficial and median veins with the intracranial venous system through the mastoid veins, which communicate with the sigmoid sinus; the communication of the upper pharyngeal veins and the veins of the upper part of the face, and the communication of the veins about the pterygoid plexus with the cavernous sinus.

The *intracranial* venous system of the region of the ear and its communications with the tympanic veins have attracted special surgical attention of late because of the direct conveyance of infection along the veins. The relations of the venous system of the middle

ear and the sigmoid sinus are very important throughout the whole extent, but chiefly so at two points. First, at the knee of the sigmoid sinus, where this sinus, a continuation of the lateral sinus, bends downward, forward, and inward; and, second, where the sigmoid

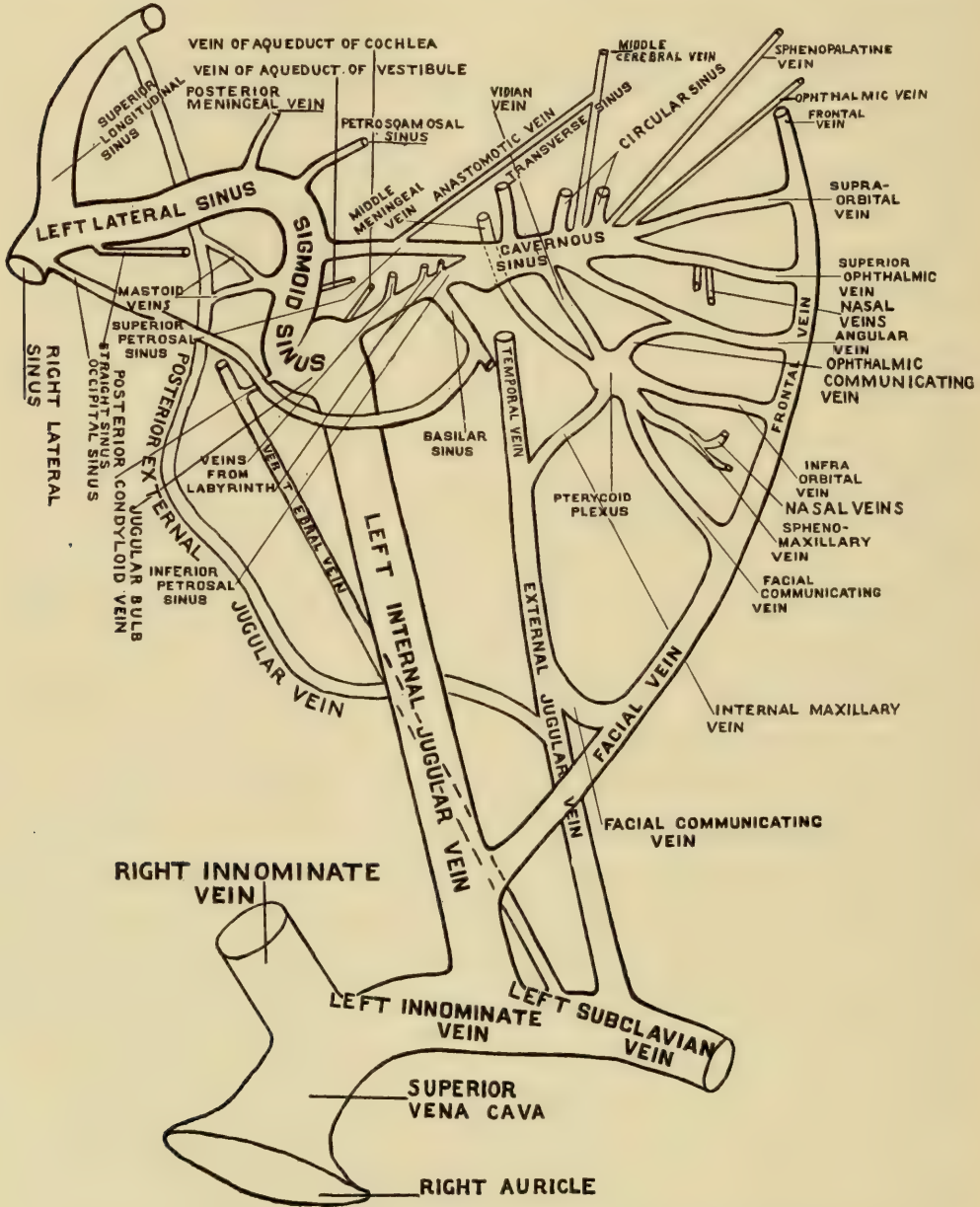


FIG. 179.—Diagram of Veins and Sinuses of Head and Neck, Left Side.

sinus empties into the posterior portion of an inverted cup, the jugular fossa, which contains the jugular bulb, the source of the internal jugular vein.

The knee of the sigmoid sinus is important because of its relation to the antrum mastoideum, in front of which it lies. The jugular

bulb is important not only because of the fact that it is the meeting place of the sigmoid and inferior petrosal sinuses, but also because of its relation to the floor and posterior wall of the cavum tympani with which it is often in immediate contact, the bony wall in some cases being partially wanting.

Next in importance are the veins and venous sinuses in immediate connection with the sigmoid sinus. These are the inferior petrosal

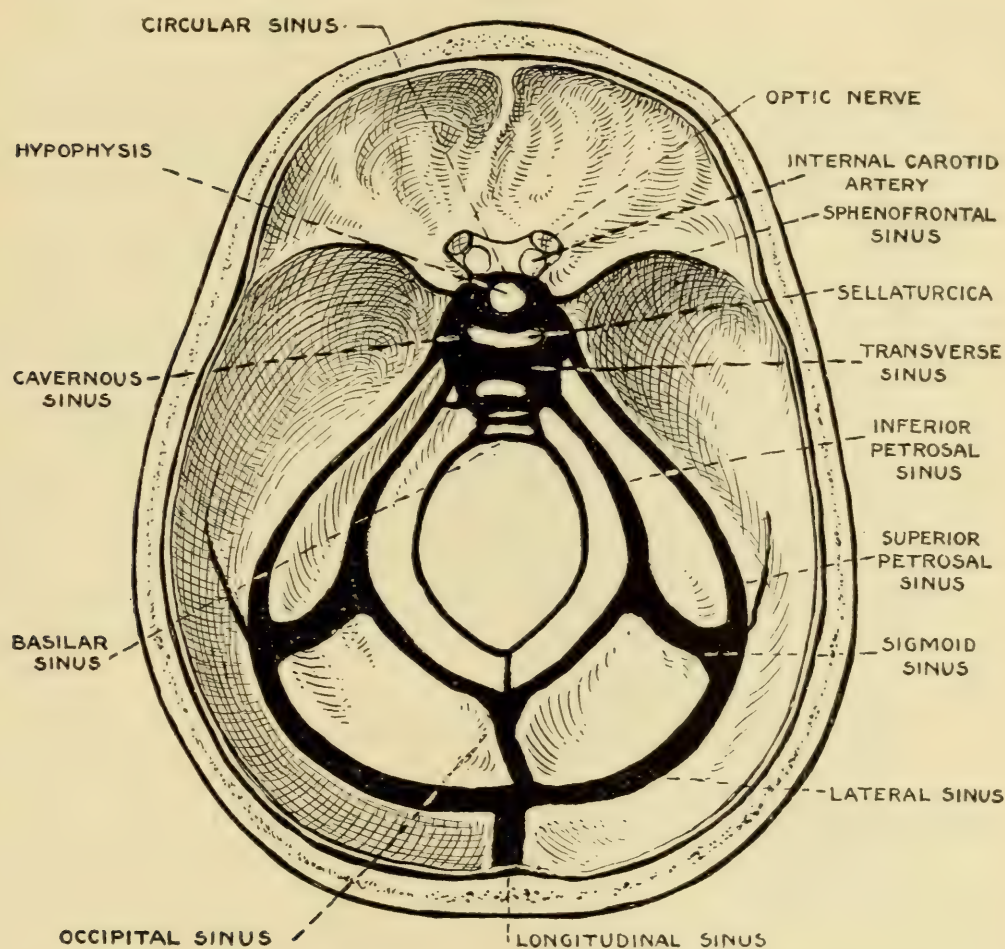


FIG. 180.—Base of Skull, Showing Venous Sinuses. Diagrammatic.

sinus, the superior petrosal sinus, the petrosquamosal sinus, the mastoid veins, and the meningeal veins. These smaller sinuses and veins, like the veins in the extremities, have a tendency to occur in pairs. The superior and inferior petrosal sinuses empty into the cavernous sinus which has direct communication with the sinus of the opposite side through the transverse and the circular sinuses. The cavernous sinus also communicates with the pterygoid plexus of veins and through this with the external jugular. Through

the veins of the upper part of the face the cavernous sinus communicates with the facial veins,

There is constant variation in the relative sizes of the several intracranial sinuses and veins. This variation in size causes a consequent variation in their exits from the cranium. These veins of exit are the internal jugular, the mastoid emissaries, the vertebral, and those which empty forward from the middle or anterior

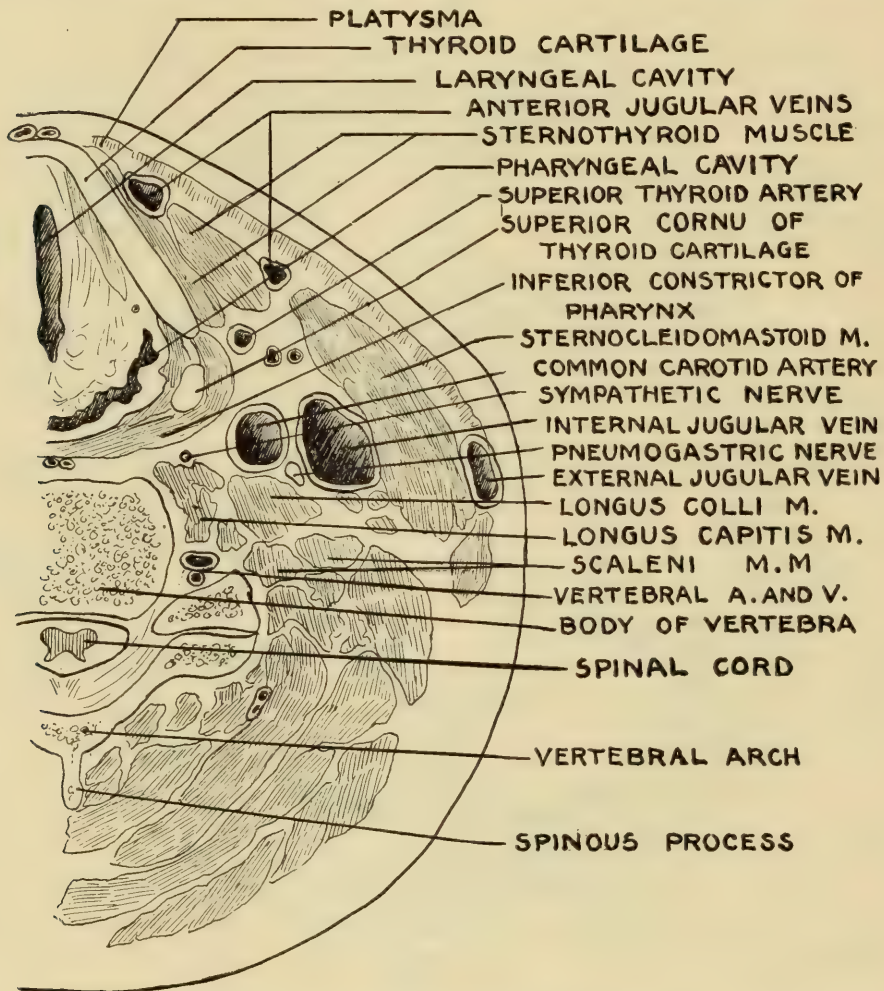


FIG. 181.—Section of Neck, Showing Topographical Position of Internal Jugular Vein.

fossa. The largest of these venous exits is the jugular foramen, or foramen lacerum posterium, which is the passage for the sigmoid sinus into the jugular bulb. Occasionally one or the other of the jugular foramina will be reduced to very small proportions. The same is true of any of the other exits.

The superior petrosal sinus connects the knee of the sigmoid sinus with the cavernous sinus. It runs along the superior angle of the

petrous pyramid and lies at the attachment of the tentorium cerebelli. Close to the orifice and at the knee of the superior petrosal sinus are other orifices for smaller cerebral veins.

The inferior petrosal sinus runs from the inner surface of the dome of the jugular bulb through the jugular foramen to the posterior end of the cavernous sinus.

The internal jugular vein rises at the jugular bulb and runs a straight course down the neck to empty into the right or left innominate vein. Throughout its course its sheath lies against the posterior inner border of the sheath of the sternocleidomastoid muscle. It lies external and anterior to the internal and common carotids, and external and anterior to the pneumogastric nerve. In its course downward, the jugular has a number of branches, the most important of which is the facial vein which joins the internal jugular a little below the middle course of the jugular. The facial veins receive blood which flows anteriorly from the superior and inferior petrosal sinuses through the cavernous sinus. It is, therefore, an important means of collateral return flow of blood from the brain in case of closure of the upper end of the internal jugular. There are extensive superficial venous anastomoses of the right and left side. The anastomoses of the large intracranial and superficial veins are also very extensive. The intracranial anastomoses are extensive and bilateral.

LYMPHATICS.

The lymphatics of the ear are abundant and communicate with the superficial and deep nodes of the neck and with the lymphatics of the nasopharynx and mediastinum. There are one or more lymph nodes situated on the outer surface of the mastoid process.

The lymph glands which drain the cavum conchae and external auditory canal are to be found in front of the tragus. The lymphatic drainage also goes into the lower anterior lymphatic vessels. The triangular fossa and the anterior surface of the helix drain into the highest mastoid gland and the upper anterior lymphatic vessels.

The helix, antihelix, and the posterior surface of the pinna drain into the mastoid and cervical glands and into the posterior lymphatic vessels. The lobe and auditory canal drain into the parotid lymph

glands and posterior lymphatic vessels. The drumhead and tympanic cavity drain into the mastoid glands. The lymph from the labyrinth drains through the aqueduct into the subarachnoid space.

The lymphatics of the labyrinth communicate both with those of the cranial cavity and with those of the middle ear.

INNER EAR OR LABYRINTH AND NERVES OF THE EAR.

The peripheral sense organs of the labyrinth are three in number, the cochlea, the semicircular canals, and the vestibule. These sense organs give rise to sensations of hearing, and change of manometric pressure to the sensation of rotatory, angular, and progressive movements in space, and to the sensation of the direction of gravitation. The sense perception of the vestibule and semicircular canals includes with the sense of gravity, the sense of the direction of motion, the sense of change in the rate of motion, as well as of rotation and of progression; to this may be still further added the sense of geotropic motion of falling. Collectively these senses are combined in the peripheral organ of equilibration. The sense of change of manometric pressure is derived from sensations of the drum membrane, and from the pressure of the foot-plate of the stapes.

The *osseous labyrinth* is lined with a thin membrane with the periosteum on one side and serous membrane covered with cuboid endothelium on the other. The membrane is continuous with the dura mater through the cribriform plate and the aqueducts. This membrane-lined tube is filled with perilymphatic fluid in which another membranous tube is partially suspended. At various points, however, the second tube is also closely attached to the bony walls. The portion of the inner tube or membranous labyrinth located in the cochlea contains the terminal nerve endings of the cochlear branch of the auditory nerve. These nerve endings are especially differentiated for the perception of molecular motion or sound vibrations. The nerve endings of the vestibular branch of the auditory nerve, which are specialized for the perception of molecular motion interpreted as position and motion in space, are found in the membranous vestibule and in the membranous semicircular canals.

The *osseous labyrinth* has five macroscopic openings in addition to very many small openings for blood-vessels: 1. the oval window or fenestra ovalis, opening into the vestibule; 2. the round window or fenestra rotunda, opening into the scala tympani of the cochlea; 3. the aquæductus cochlæ, opening into the scala vestibuli of the cochlea; 4. the aqueductus vestibuli, opening into the vestibuli, and 5. the cribriform openings through the fenestrated plate of the internal auditory meatus.

The *osseous vestibule* is the common central cavity, its inner wall lying against the peripheral end of the internal meatus, and its

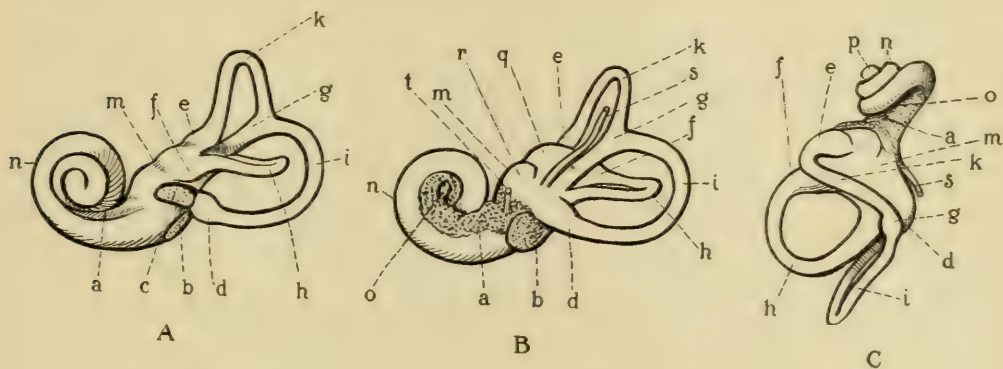


FIG. 182.—FIG. A, Left Labyrinth, Outer Side. B, Right Labyrinth, Inner Side. C, Left Labyrinth from above.

a, Foramina for cochlear nerve; b, Fenestra rotunda; c, Fenestra ovalis; d, posterior ampulla of semicircular canal; e, Superior ampulla of semicircular canal; f, External ampulla of semicircular canal; g, Common limb of superior and posterior semicircular canals; h, External canal; i, Posterior canal; k, Anterior canal; m, Vestibule; n, Cochlea; o, Base of cochlea; p, Cupola of cochlea; q, Recessus hemiellipticus of macula acustica utriculi; r, Recessus hemisphericus of macula acustica, and s, Aquæductus vestibuli; t, Aquæductus cochlæ.

outer wall surrounding the fenestra ovalis. It lies behind the cochlea and in front of the semicircular canals. Posteriorly and superiorly the osseous vestibule shows the orifices of the semicircular canals, five in all, one of the openings being common to two canals. Anteriorly and inferiorly, there is an aperture into the scala vestibuli of the cochlea. Near the orifice of the posterior and superior semicircular canals there is a tiny foramen leading into the aqueduct of the vestibule.

The *semicircular canals*, three in number, are situated above and behind the vestibule. The canals are nearly at right angles to each other, representing the three dimensions of space. One extremity of each canal is larger than the other extremity, and is

called the *ampulla*. The anterior or superior canal of one side, and the posterior of the other, lie in parallel planes. Both external canals are in the same plane. The anterior or superior canal lies in a vertical plane at right angles to the posterior surface of the petrous pyramid. The posterior is also vertical, but lies parallel to the posterior surface of the pyramid and is, therefore, at right angles to the superior as well as to the external or horizontal canal, which lies in a horizontal plane.

The *cochlea*, as its name implies, is a conchoidal spiral tube, the cochlear canal, which is wound into a cone, making two and a half turns about an axis, *the modiolus*, the latter having a nearly horizontal axis directed outward. The base of the cone rests on the bottom of the internal meatus and is perforated for the filaments of the cochlear nerve. The modiolus is also perforated for the cochlear nerve filaments. The coils of the cochlear canal are known as the apex, central and basilar. *The lamina spiralis* is a spiral shelf attached to the inner wall of the spiral cochlear canal, partially dividing it into an upper tube, called *scala vestibuli*, and a lower tube called *scala tympani*. This *scala tympani* does not open directly into the vestibule, but communicates with the typanum through the *fenestra rotunda* or round window. It opens into the vestibule only over the *lamina spiralis*. The *lamina spiralis* is perforated for the passage of the fibers of the cochlear nerve to the *papilla acustica*, or organ of Corti, and contains at its base a spiral enlargement of these canals, called the *spiral canal*, for the spiral-ganglion of the cochlear nerve. Close to the *fenestra rotunda* and on the inner wall of the *scala tympani* there is a tiny foramen, the *aqueduct of the cochlea*.

The serous membrane lining the osseous labyrinth also covers the membranous labyrinth wherever it is not attached to a bony wall. There is a large perilymphatic cistern adjacent to the oval window, 3 mm. in depth and 3 mm. from before backward. A tube of the lining membrane passes from the vestibule into each semi-circular canal and into the *scala vestibuli* of the cochlea, lining the *scala vestibuli* to the cupola or apex; then continuing through the *helicotrema* or passage-way at the apex of the cochlea, into the *scala tympani*, which it also lines, it finally forms a blind pouch at the lower end of the *scala tympani*. The *membrana tympani secundaria* of the round window closes the lower end of the *scala tympani*.

Slightly above the round window on the inner wall of the *scala tympani*, the perilymphatic membrane leads into a narrow membranous tube, the *ductus perilymphaticus*, which lines the osseous aqueduct of the cochlea and empties into the subarachnoid space at the lower posterior border of the petrous bone, close to the jugular bulb. Thus, the subarachnoid space and the perilymphatic space communicate. The perilymphatic space communicates with the subdural space through the porus acusticus or cribriform plate of the internal meatus.

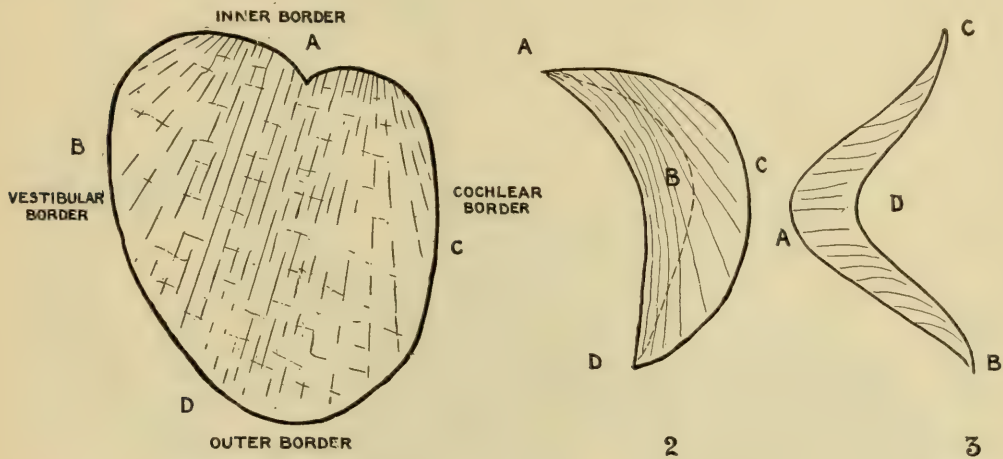


FIG. 183.—Left Membrana Tympani Secundaria. 1, Outer Surface; 2, View from Cochlear Border; 3, View from Outer Border, Diagramatic

The *membrana tympani secundaria* looks backward, downward, and outward, and is attached in the frame of the fenestra rotunda at the inner end of the round pelvis. The area of the membrane is about twice the area of the tympanic orifice of the round pelvis. It is somewhat cordate, with nearly equal diameters, a rounded convex outer or anterior border, and a concave inner or posterior border. The membrane does not lie flat, but is folded along its inner border to fit the undulations of the inner border of the round window. The chief fold of the membrane is concave outward, the minor fold convex. The membrane is composed of a connective tissue portion, or *membrana propria*, with fibers radiating from the apex of the curve of the membrane. Externally, it is covered by thin mucous membrane; internally, by an endothelial lining, bathed in the perilymph of the perilymphatic tube of the *scala tympani*. The *membrana tympani secundaria* closes the extremity of the *scala tympani* in the basal whorl of the cochlea. It is nearly at right angles to the axis of the *scala tympani*.

The *endolymphatic sac or true membranous labyrinth* is a tube with its walls parallel to the osseous walls, except in the vestibule. The membranous labyrinth is lined with epithelium, and is completely surrounded by the perilymphatic sac, except where attached to the osseous wall. The membranous labyrinthine tube has three chief parts connected only by very narrow conduits. Two of these parts are placed in the vestibule; the third, in the cochlea. The latter, which

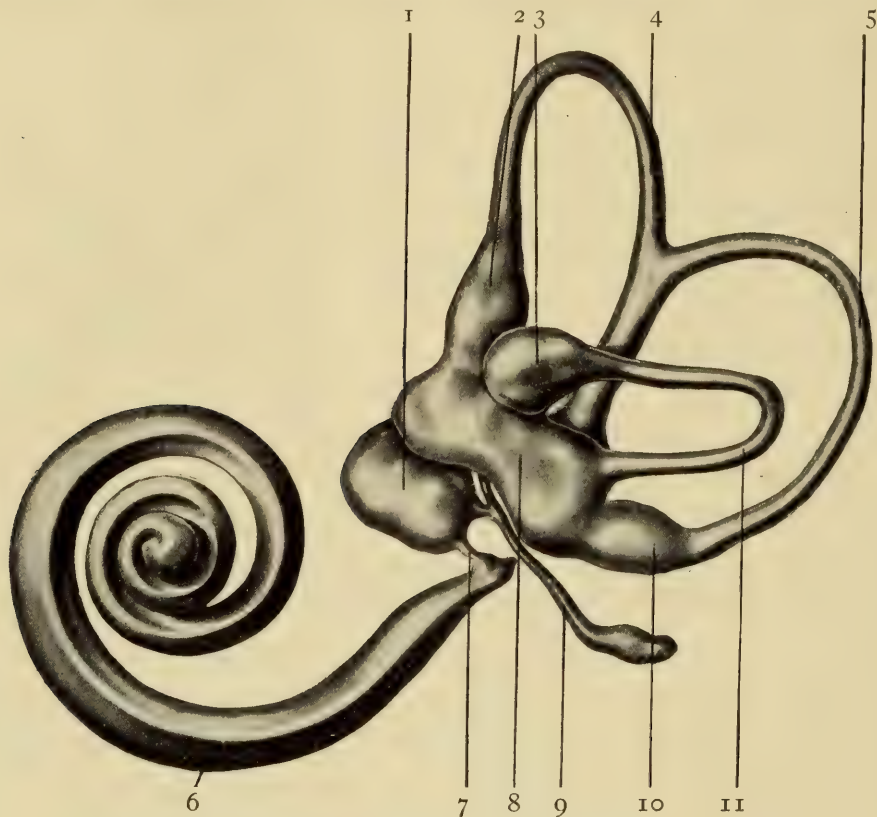


FIG. 184.—Diagram of Membranous Labyrinth. (Deaver.)

1, Saccule; 2, Ampullæ; 3, Ampullæ; 4, Superior semicircular canal; 5, Posterior semicircular canal; 6, Scala media of cochlea; 7, Canalis reuniens; 8, Utricle; 9, Ductus endolymphaticus; 10, Ampulla; 11, External semicircular canal.

is called the *scala media*, is the anterior one. It lies against the outer osseous wall of the cochlear canal, between this wall and the lamina spiralis, and between the scala vestibuli and tympani. The posterior of the two parts of the membranous labyrinth in the vestibule—the utricle—sends branches through the semicircular canals; the third part of the membranous labyrinth, the saccule, which is a small rounded bag, communicates with the utricle through the forked end of the *ductus endolymphaticus*, and with the *scala media* of the cochlea by a small tube, called the *canalis reuniens*.

The endolymphatic sac has a drainage-tube like the perilymphatic sac. In this case, the *ductus endolymphaticus* passes through the *osseous aquæductus vestibuli*. The duct opens from the saccule and empties into a small lymph system, the *saccus endolymphaticus* or *recessus Cotugni* in the dura mater on the posterior surface of the petrous bone. The duct drains both the utricle and the saccule by means of its forked extremity, and communicates with

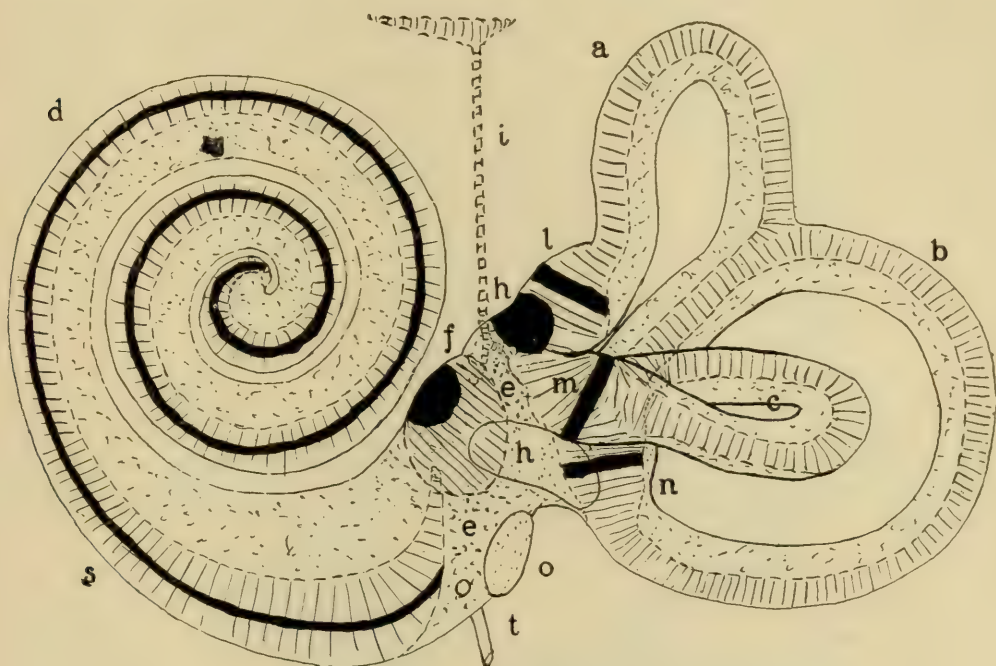


FIG. 185.—Diagram of Right Labyrinth, Viewed from Outer Side. The Perilymphatic Tube is Closed. The Endolymphatic Tube is Cross-lined. The Neuro-epithelial areas are black.

a, Anterior semicircular canal; *b*, Posterior semicircular canal; *c*, External semicircular canal; *d*, Cochlea; *e*, Vestibule; *f*, Sacculus and Macula acustica sacculi; *g*, Utriculus and macula acustica utriculi; *i*, Ductus endolymphaticus; *l*, Ampulla of superior semicircular canal and crista acustica; *m*, Ampulla of external semicircular canal and crista acustica; *n*, Ampulla of posterior semicircular canal and crista acustica; *o*, Round window; *p*, Oval window; *s*, Scala media and papilla acustica; *t*, Ductus perilymphaticus.

the subdural and subarachnoid spaces. The utricular arm of the *ductus endolymphaticus* opens from the utricle near the common orifice of the superior and posterior semicircular canals. The saccular arm of the duct opens low down on the outer wall of the saccule. The saccule and the utricle each have a saucer-shaped *macula acustica*, made up of neuro-epithelium consisting of hair cells and filiform cells. The neuro-epithelium is connected with the vestibular nerve and is covered with *otoliths* suspended among

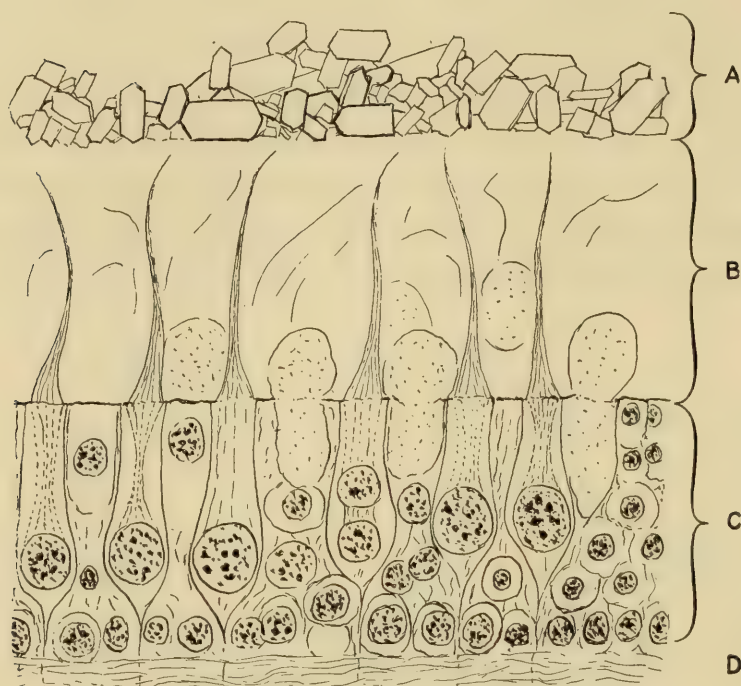


FIG. 186.—Microscopic Section of Neuro-epithelial Structure of Macula Acustica Saculi.

a, Otoliths suspended in mucus; *b*, Hairs of the neuro-epithelial cells, mucous cells and shreds of mucus; *c*, Neuro-epithelial cells and supporting cells; *d*, Basement membrane.

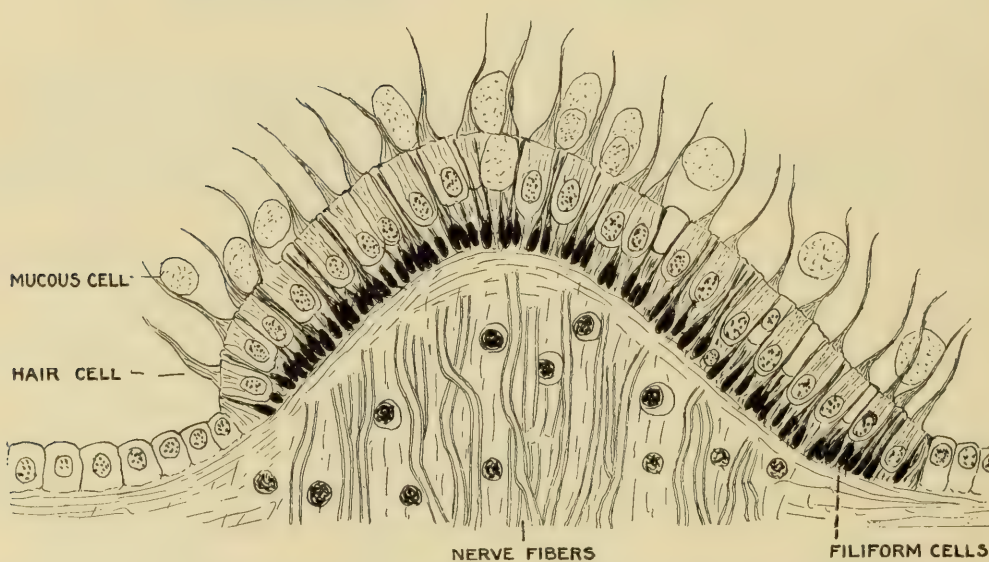


FIG. 187.—Transverse Microscopic Section of Crista Acustica Utriculi. Shows the hairs of the epithelium agglutinated in bundles.

the hairs in mucous jelly. These otoliths are crystals of carbonate of lime, about 5 micromillimeters long. The *macula acustica* of the saccule has its curved concave surface directed backward, outward, downward, and upward; in the utricle it is directed inward, backward, and downward. The endolymphatic or membranous semicircular canals are much smaller than the perilymphatic or osseous canals. The membranous canals are attached to the concave outer side of the osseous canals. Each membranous canal has an ampulla or enlargement of one end, corresponding to the ampulla of the osseous canal. Situated on the convex side of each ampulla is a *crista acustica* corresponding to the **maculæ acusticæ** and composed of neuro-epithelium furnished with sensitive hairs.

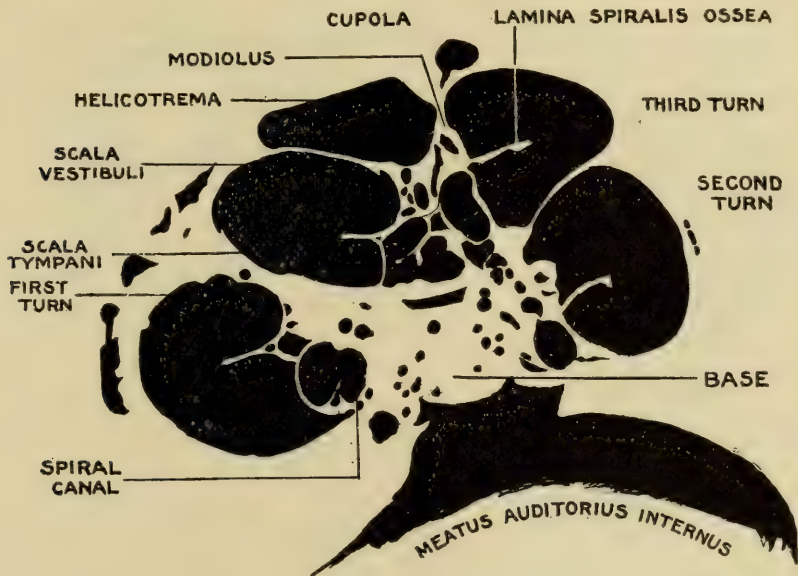


FIG. 188.—Cross section of macerated cochlea (enlarged).

In describing the cochlea, it is treated as a distinct conical object, with base and apex, without any reference to the planes of the body. The *membrana basilaris* supports the papilla acustica or organ of Corti, and extends outward from the *labium tympanicum* or lower lip of the limbus to the outer wall of the cochlea, thus forming the tympanic or lower wall of the scala media. The limbus is the thickened epithelio-periosteum of the free edge of the lamina spiralis. The basilar membrane is composed of a tendinous basement membrane running from the lamina spiralis to the ligamentum spirale.

The delicate membrane of Reissner, on the vestibular side, endothelium, and on the median side, epithelium, without basement

structure, rises from the upper surface of the inner side of the labium vestibuli of the limbus spiralis and extends at an oblique angle to the outer upper wall of the cochlear canal, forming the upper part or vestibular wall of the scala media.

The *scala media* is a space included between the basilar membrane, the membrane of Reissner, and the *ligamentum spirale*. It is triangular on section, and contains the *papilla acustica*, which is formed by elongated neuro-epithelial cells, furnished with long sensitive hairs.

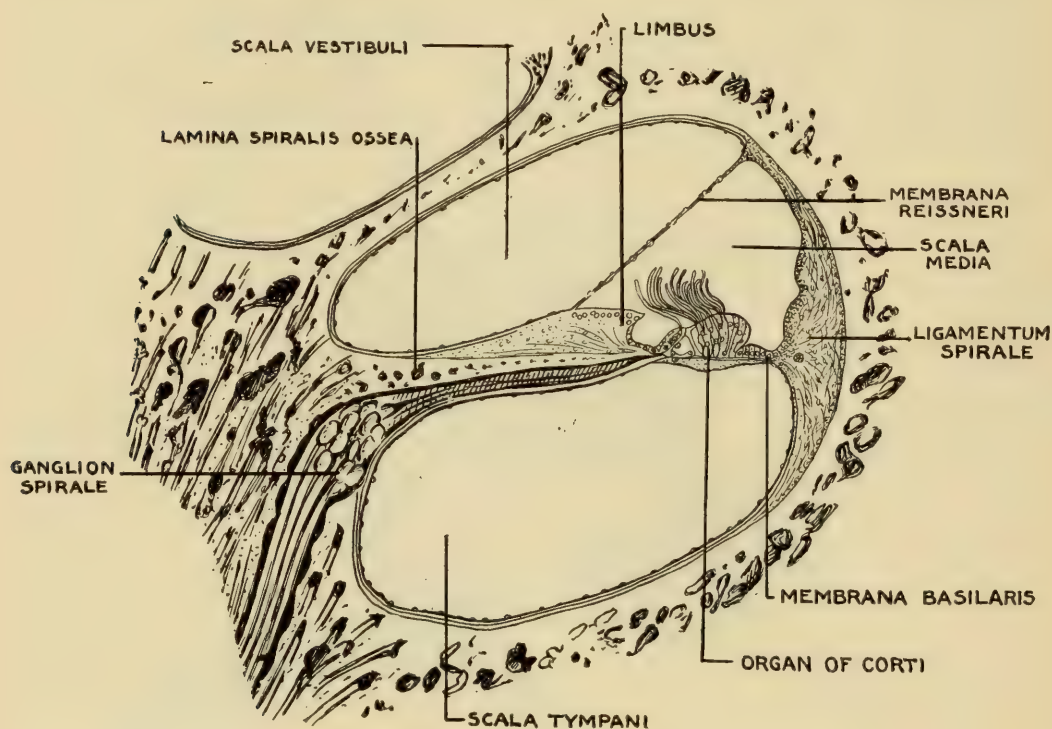


FIG. 189.—Cross-section of First Whorl of Cochlea (magnified).

These hair cells are connected with fibers of the cochlear nerve which passes from the modiolus through the *lamina spiralis*.

The membrana tectoria is a mass of the delicate hairs which spring from the hair cells. This membrane is the most delicate tissue in the body, and cannot be treated by any reagents without great alteration. In most histological preparations the fibers are agglutinated and, detached from the hair cells, form a membrane with horizontal fibers attached to the limbus, while their outer margin comes into contact with the hair cells of the organ of Corti. Various manipulations of the specimens have given every conceivable variation of artifact.

The *auditory or eighth cranial nerve* has a very complicated central course with many central connections. It is composed of two distinct parts differing in development, function, and histological characteristics, in origin, distribution, and arrangement of peripheral ganglia. One part of the auditory nerve, the cochlear nerve, conducts tone impressions. This nerve is distributed to the spiral ganglion at the base of the lamina spiralis. The peripheral ganglia of the nerve are in close connection with the sensory epithelium of the papilla acustica. The other part of the auditory nerve, the vestibular nerve, conducts sensations of motion and position in

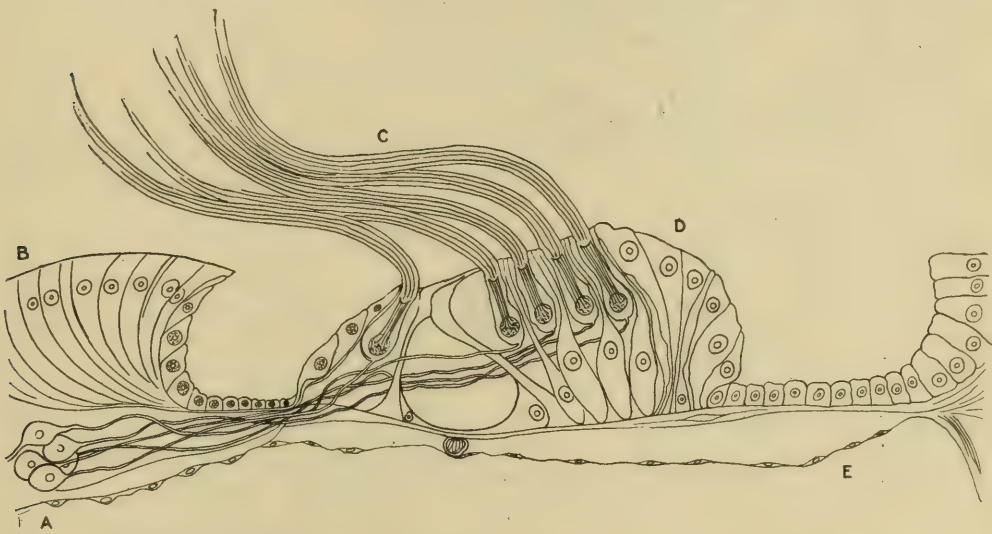


FIG. 190.—Vertical Radial Microscopic Section, Lamina Spiralis Ossea, Basilar Membrane and Papilla Acustica.

a, Ganglion cells and cochlear nerve fibers; *b*, limbus laminæ spiralis; *c*, auditory hairs; *d*, Papilla acustica; *e*, Basilar membrane; *a-e*, Scala tympani; *b, c, d*, Scala media.

space and is distributed to the *maculæ acusticæ* of the vestibule and the *cristæ* of the semicircular canals.

The cochlear and vestibular nerves are closely associated in the trunk of the eighth nerve. They lie exteriorly to the facial nerve in the internal auditory canal. The cochlear nerve lies below and in front of the vestibular. They accompany each other around the posterior border of the middle peduncle of the cerebellum, and in company with the facial nerve, wind round the restiform body and enter the pons Varolii at its lower border in a groove between the olivary and restiform bodies.

The cochlear nerve fibers nearly all go to the opposite side of the brain, and are especially associated with the cortical centers.

They also have many motor connections for reflex movement, notably, with the nuclei for the motor nerves of the ocular muscles,

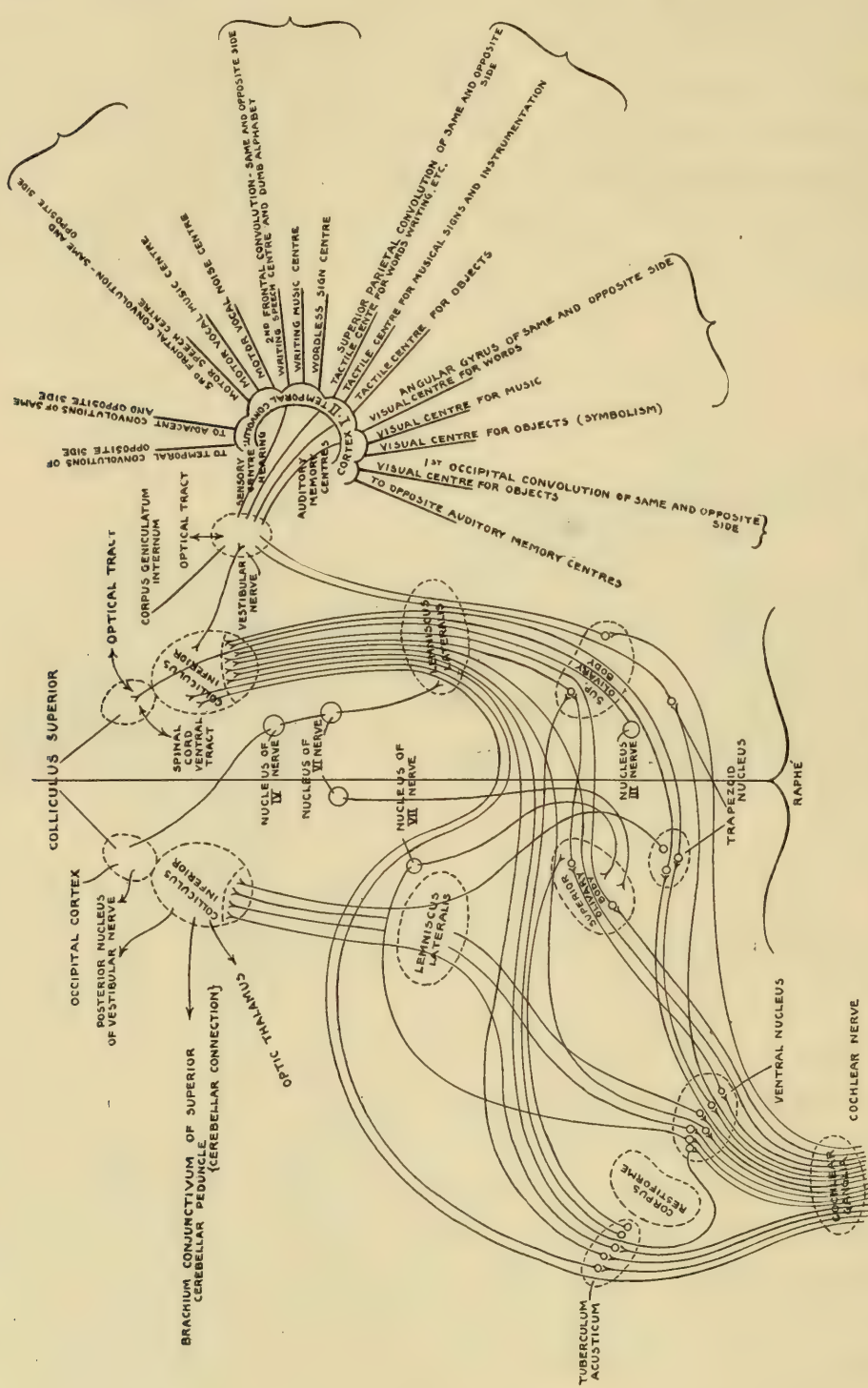


FIG. 191.—Diagram of Cochlear Nerve and Auditory Tract.

third, fourth, and sixth cranial nerves. There is a direct connection with the nucleus of the facial nerve.

The cochlear nerve fibers which pass to the colliculus inferior

are associated with fibers of the vestibular nerve, fibers from the optic thalamus, the superior cerebellar peduncle, the corpus geniculatum internum, and the colliculus superior. In the colliculus superior the auditory tract is associated with fibers from the occipital cortex, the ophthalmic tract, the anterior horn of the spinal cord, and with the fibers of the vestibular nerve. The auditory tract passes through the corpus geniculatum internum where it is associated with fibers of the vestibular nerve and fibers from the optic tract.

The auditory tract comprises the conduction, perception, conception, and memory centers for sounds, and is intimately connected with the intellectual and emotional sphere, which is the highest development of the brain. Their functions depend for their existence on language, and language is dependent fundamentally on the function of audition.

The sensory auditory center is situated in the first temporal convolution and is continuous with the auditory memory center. It is connected with the auditory center of the opposite side and with the neighboring convolutions.

(Lesions of the anterior portion of the auditory center are associated with sensory aphasia; those of the posterior portion with visual and speech difficulties, motor aphasia.)

The auditory memory center is connected with the following centers of the same and opposite sides.

The third frontal convolution, the motor speech center, motor vocal music center, motor vocal noise center; the second frontal convolution, writing speech center, dumb alphabet, writing music center, wordless sign center; the superior parietal convolution, tactile center for words and writing, tactile center for musical signs and instruments, tactile center for objects; angular gyrus, visual center for words, visual center for music, visual center for objects (symbolism); first, occipital convolution, visual center for objects. In right-handed persons the left hemisphere performs the functions connected with audition.

Vestibular Nerve. Central Course.—The central origin and connection of the vestibular nerve are chiefly with the sensory and dynamic equilibrational and co-ordinational mechanisms, which bring the vestibular nerve into close relation with the cerebellum and nuclei for the motor nerves of the cranium, with the motor

tract of the spinal cord, and with the cochlear nerve. The vestibular nerve is also brought into close relation with the protective mechanism of the sympathetic nervous system through the vagus. The central distribution of the vestibular nerve is chiefly to the same side, very few fibers going to the opposite cerebellum.

From Deiter's nucleus, the posterior nucleus, and the nucleus triangularis, the nerve runs direct to the cerebellum of the same and opposite side. Fibers of the vestibular nerve are connected

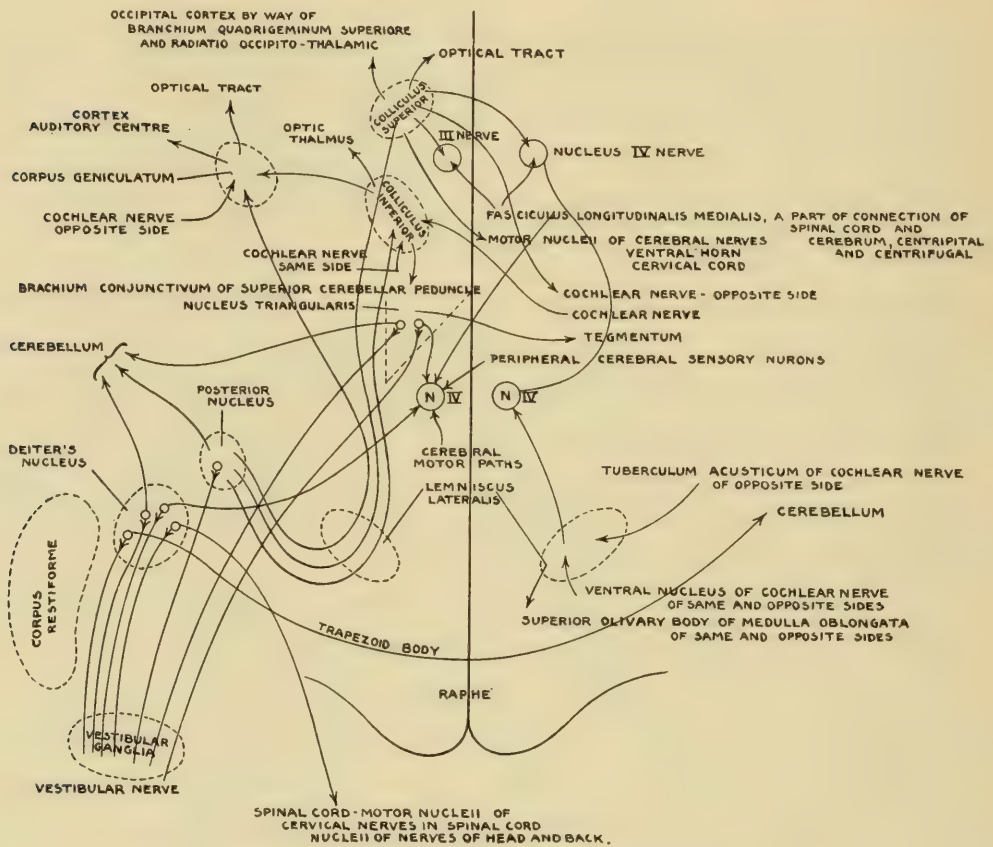


FIG. 192.—Vestibular Nerve and Tract.

with the sixth cranial nerve through Deiter's nucleus and the nucleus triangularis, and are brought into close relation with this nerve in the *lemniscus lateralis*. Vestibular fibers are brought into connection with the optical tract through the corpus geniculatum, the tegmen and colliculus superior. They are brought into relation with the sixth nerve in the lemniscus lateralis, and with the fourth nerve of the opposite side in the colliculus superior; with the third nerve through the colliculus inferior.

Vestibular fibers go from Deiter's nucleus to the motor nuclei

of the cervical nerves, nerves for the head, and back in the spinal cord of the same side.

The vestibular fibers are connected through the lemniscus lateralis with the superior olivary body of the medulla oblongata of the same and the opposite side, with the ventral nuclei of the cochlear nerve of the same and opposite side, and with the tuberculum acusticum of the cochlear nerve of the opposite side.

Vestibular fibers are brought into connection through the corpus geniculatum with the cochlear nerve of the opposite side, with the cortical auditory centers and with the colliculus inferior.

Through the nucleus triangulari, the vestibular fibers are connected with the tegmentum of the opposite side.

Fibers of the vestibular nerve are connected with the occipital cortex by way of the brachium quadrigeminum superior and radiatio-occipital thalamic, and with the motor nuclei of central nerves and ventral horn of cervical cord of opposite side.

Through the colliculus inferior the vestibule fibers are connected with the optic thalamus, with the cochlear nerve of the same and opposite side, with the brachium conjunctivum and with the inferior cerebellar peduncle.

NERVES ABOUT THE EAR.

Motor Nerve Supply.—The extrinsic muscles of the ear are supplied by the posterior auricular nerve, a branch of the facial, and by the anterior auricular nerve which comes from the right temporal, both branches of the facial nerve. The stapedius muscle receives its nerve supply from the stapedius nerve, a branch of the facial. The tensor tympani muscle is supplied by the tensor tympani nerve, made up in the otic ganglion from the maxillary division of the fifth nerve, from the facial nerve, through the great superficial petrosal nerve from the geniculate ganglion, through the spurious hiatus, anterior lacerated foramen, and Vidian canal to Meckel's ganglion, and also from the pterygo-palatine nerves. The tensor veli muscle is supplied by the maxillary division of the fifth nerve through the otic ganglion; the retrahens tubæ, dilator tubæ, or levator palati by the pharyngeal plexus and vagus nerve, through the superior palatine nerve and Meckel's ganglion, and by the facial nerve through the great superficial petrosal. The vasoconstrictors

of the ear are the sympathetic nerves. The chorda tympani nerve of the seventh nerve, pars intermedia, is secretory, and supplies the submaxillary and sublingual salivary glands, and the sense of taste for the anterior half of the tongue. The chorda tympani nerve from the intermediary nerve of Wrisberg, accompanies the facial nerve to the stylomastoid foramen, and re-enters the bone through a foramen of its own, opening internally and anteriorly to the stylomastoid foramen. This nerve then passes through its canal and enters the tympanum, close to the posterior end of the annulus tympanicus and crosses the cavum between the long process of the anvil and the handle of the hammer. It passes out of the tympanum through the foramen or Huguier, parallel to the fissure of Glaser, to join the lingual nerve, a branch of the fifth nerve.

Sensory Nerve Supply.—The auricle, upper part of the external canal and drum are supplied by the auriculo-temporal nerve, a branch of the fifth nerve. The posterior part of the auricle, the auricular muscles, and the auditory canal are supplied by the auricularis magnus, a branch of the third cervical nerve, and by the other branches of the cervical plexus. The cartilaginous meatus, the posterior wall of the bony meatus, and part of the posterior surface of the auricle are supplied by the auricular branch of the vagus, through the tympano-mastoid fissure. The tympanic cavity is supplied by the tympanic plexus, derived chiefly from the glossopharyngeus. The Eustachian tube is supplied by the tympanic plexus, together with the carotico-tympanic branch of the small deep petrosal nerve, from the internal carotid plexus of the sympathetic, and also by the tympanic (Jacobson's nerve) from the petrous ganglion. The tympanic plexus is formed by Jacobson's nerve, a branch of the glossopharyngeal nerve. This nerve divides over the promontory forming the tympanic plexus, one branch joining the carotid plexus of the sympathetic, while another, called the small deep petrosal, passes through a foramen in the tegmen to join the small superficial petrosal which connects with the facial nerve and through the otic ganglion with the fifth nerve. A third branch—the great deep petrosal—joins the great superficial petrosal which connects the facial and Vidian nerves, an efferent nerve coming from the Vidian canal and the posterior branch of the sphenopalatine ganglion. The chorda tympani nerve is the nerve of taste for the anterior half of the tongue.

The Reflex Paths and the Temporal Plexus of Nerves.—This extensive nervous anastomosis admits of almost an unlimited variety of reflex motor, sensory and sympathetic phenomena.

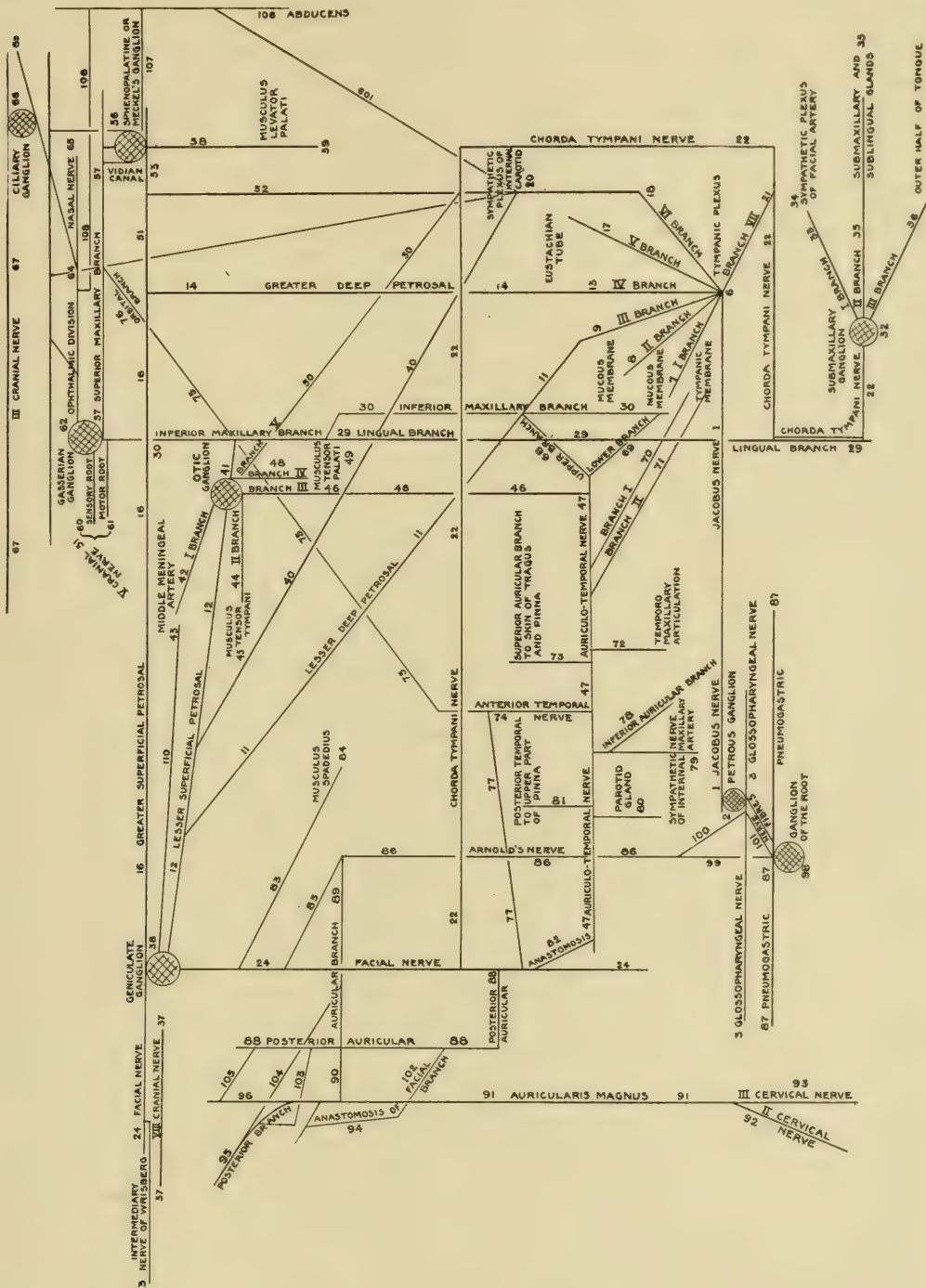


FIG. 193.—Diagram of Nerve connection about the Ear.

(1) Jacobson's nerve from the (2) petrous ganglion of the (3) glossopharyngeal nerve goes through Jacobson's canal in the jugular fossa, and passes into the tympanic cavity through a special foramen in the floor of the tympanum. It then forms the (6) tympanic plexus on the promontory. (7) First branch of the tympanic plexus goes to the mucous membrane of the tympanum. (8) Second branch of the tympanic plexus to

the mucous membrane of the tympanum. (9) Third branch of the tympanic plexus going through a special foramen on the anterior surface of the petrous bone to form the (11) lesser deep petrosal which joins the (12) lesser superficial petrosal. (13) Fourth branch of tympanic plexus forms (14) greater deep petrosal, and leaves the anterior surface of the petrous bone through a small foramen a little behind the hiatus of Fallopius, and joins the (16) greater superficial petrosal. (17) Fifth branch of the tympanic plexus goes to the Eustachian tube. (18) Sixth branch of the tympanic plexus goes through a small foramen in the carotid canal and joins (20) sympathetic plexus of the internal carotid. (21) Seventh branch of the tympanic plexus of the (22) chorda tympani nerve, which, as the (23) intermediary nerve of Wrisberg, accompanies the (24) facial nerve as it enters the internal auditory canal, and follows the facial till it approaches the stylomastoid foramen, where the chorda tympani leaves the facial nerve and passes through the canal of the cord, emerging into the tympanic cavity through the posterior canal of the cord, passes through the tympanic cavity and leaves it through the anterior canal of the cord, or canal of Huguier. The chorda tympani nerve (22), after it has been joined by the seventh branch of the tympanic plexus (21) joins the (29) lingual branch of the (30) inferior maxillary branch of the (31) fifth cranial nerve. When the chorda tympani nerve (22) leaves the lingual (29) it forms the (32) submaxillary ganglion, which gives off branches: (33) first branch of submaxillary ganglion to the (34) sympathetic plexus of the facial artery. (35) Second branch of the submaxillary ganglion to the submaxillary and sublingual glands. (36) Third branch of the submaxillary ganglion to outer half of tongue. The facial (24), together with the intermediate nerve of Wrisberg (23) (chorda tympani), and the (37) eighth cranial or auditory nerve, enter the internal auditory meatus. The facial nerve proceeds to the (38) geniculate ganglion, and gives off two branches through the hiatus of Fallopius, or through separate foramina; one branch, the greater superficial petrosal (16), the other, the lesser superficial petrosal (12), which joins the lesser deep petrosal (11) and sends a (40) branch to the sympathetic plexus of the internal carotid (20). The lesser superficial petrosal (12) joins the (41) otic ganglion, which is connected with the inferior maxillary nerve (30) and gives off five branches; (42) First branch of otic ganglion to the (43) sympathetic plexus of the middle meningeal artery. (44) Second branch of the otic ganglion to the (45) musculus tensor tympani. (46) Third branch of the otic ganglion joins the (47) auriculo-temporal nerve a branch with two roots from the inferior maxillary (30). (48) Fourth branch of otic ganglion to (49) musculus tensor palati. (50) Fifth branch of otic ganglion to chorda tympani. (22) The greater superficial petrosal (16), a branch from the geniculate ganglion (38), joins the greater deep petrosal (14) which is a continuation of the fourth branch (13) of the tympanic plexus (6) and passes through a groove on the anterior surface of the petrous bone, and sends a (52) branch to the sympathetic plexus (20) of the internal carotid artery, then forms the (53) Vidian nerve, and passes through the foramen lacerum anterium and the Vidian canal, and forms the (56) sphenopalatine, or Meckel's ganglion, with branches from the (57) superior maxillary branch of the fifth cranial nerve (31). The sphenopalatine ganglion sends a (58) branch to the (59) musculus levator palati. The fifth cranial nerve (31) is composed of a (60) sensory root, and a (61) motor root. The sensory root forms the (62) Gasserian ganglion, which has three branches: First, the inferior maxillary nerve (30) which is made up of a sensory nerve, and a motor root (61), which passes down through the foramen ovale. Second branch, the superior maxillary nerve (57) and (64) third branch, the ophthalmic division of the fifth cranial nerve. A branch of this, the (65) nasal nerve, joins the (66) ciliary ganglion of the (67) third cranial nerve. The inferior maxillary nerve (30), first branch of the Gasserian ganglion (62), gives off two branches, the (68) upper branch and the (69) lower branch, which unite to form the auriculo-temporal nerve (47). This nerve has two branches (70 and 71) to the tympanic membrane. The auriculo-temporal nerve (47), sends a (72) branch to the temporo-maxillary articulation and (73) a superior auricular branch to the skin of tragus and pinna. The auriculo-temporal (47) gives a branch (74), the anterior temporal nerve, to the temporal region. This has (75) a branch which joins the (76) orbital branch of the superior maxillary nerve (57) and has another (77) branch which communicates with the facial nerve (24). (78) The inferior auricular branch of the auriculo-temporal, (47) supplies the ear below the external meatus and sends a (79) branch to the sympathetic nerve of the internal maxillary artery, and (80) a branch of the auriculo-temporal (47) to the parotid gland. The auriculo-temporal has another branch, (81) the posterior temporal to the upper part of the pinna, an (82) anastomosis of the auriculo-temporal (47) and the facial (24) nerves in front of the cartilage-

inous meatus. Facial nerve (24) leaves the geniculate ganglion (38) giving off (83) a branch to the (84) musculo stapedius (85), a branch to the facial nerve from (86) Arnold's nerve, which passes through a small foramen in the jugular fossa from (87) the pneumogastric. The facial nerve (24), after passing through the stylomastoid foramen, joins the auriculo-temporal nerve (47) through the anastomosis (82) and has a branch, (88) the posterior auricular, which is distributed to the superior part of the cartilaginous canal and some of the posterior surface of the auricle. The posterior auricular nerve joins (89) the auricular branch of the pneumogastric (87) or a branch of Arnold's nerve (86). These nerves anastomose on the posterior wall of the canal through (90) a branch with (91) the auricularis magnus, a branch from the (92) second cervical nerve and (93) third cervical nerve. The auricularis magnus (91) has three branches: (94) first branch to the face communicates with the facial nerve (24) through (102). (95) Second branch to the posterior part of the meatus and auricle communicates with the auricular branch (88) of the facial (24) through (103) and communicates with the pneumogastric (87) via (89) through (104). (96) Third branch to the mastoid and integument behind the ear, communicates through (105) with the auricular branch (88) of the facial (24). The glossopharyngeal nerve (3) and the pneumogastric nerve (87) pass through the foramen rotundum. The pneumogastric nerve (87) forms (98) the ganglion of the root which sends off (99) a branch which unites with (100) a branch from the petrous ganglion (2) to form Arnold's nerve (86). The petrous ganglion (2) and the pneumogastric ganglion of the root (98) are connected by (101) nerve fibers. Anastomosis of the facial branch (94) of the auricularis magnus (91) with the facial nerve (24). (103) Communicating branch between the posterior branch (95) of the auricularis magnus (91) and the auricular branch (88) of the facial (24). (104) Connecting branch between the posterior branch (95) of the auricularis magnus (91) and the auricular branch (89) of Arnold's nerve (86) from the pneumogastric (87). (105) Communication between the mastoid branch (96) of the auricularis magnus (91) and the posterior auricular branch (88) of the facial nerve (24). (106) Sixth cranial nerve (abducens). (107) Communication of the sixth (106) nerve and the sphenopalatine ganglion (56). (108) Communication of the sixth nerve (106) and the ophthalmic division (64) of the fifth nerve (31). (109) Communication of the sixth nerve (106) and the carotid plexus (20). (110) External petrosal from geniculate ganglion (38) to meningeal plexus (43).

The temporal plexus of nerves, or the plexus of nerves associated with the ear, contains a complicated network of sensory, motor, and sympathetic nerve fibers with nervous ganglia and plexiform anastomoses between the III (motor oculi), V (trigeminus), VI (abducens), VII (facial), X (pneumogastric), and XII (hypoglossal) cranial nerves and the cervical plexus and the sympathetic of the arterial and venous plexuses, thus connecting the cranium, face, throat, neck, circulatory sympathetic plexus, gastric, pulmonary, and cardiac nerves.

Common motor and sensory reflexes occur through the third, fifth, seventh, ninth, and tenth cranial nerves, and through the sympathetic nerves. Ear stimulations give rise to motor oculi disturbances through the third nerve, including ciliary reflexes. Saliva and tear disturbances occur through the fifth nerve; spasmodic facial reflexes through the seventh nerve; spasmodic pharyngeal reflexes through the ninth nerve. Disturbances of the larynx, heart, and stomach occur through the tenth nerve.

Vasomotor disturbances take place through the sympathetic

nerves. Aurotrophic reflexes coming toward the ear cause motor disturbances, which give rise to tinnitus. They come from the fifth nerve, affecting the tensor tympani muscle, and from the seventh nerve, affecting the stapedius muscle. Reflex pain sensations come to the ear through the fifth nerve from the teeth and gums; through the ninth nerve from the pharynx; through the tenth nerve from the larynx. Reflex pain emanating from the ear affects the teeth and dura mater through the fifth nerve. Reflexes from the ear through the ninth and tenth nerves cause choking and coughing. The sympathetic nerve is affected by or affects the ear reflexly. The ear is affected by reflex congestion or anemia, causing trophic and sensory phenomena (tinnitus). The ear influences the cerebral circulation through the carotid plexus, and causes anemia or hyperemia of the brain.

ANATOMY OF THE INFANT'S EAR AND SUBSEQUENT DEVELOPMENT.

The sense of hearing does not appear until the fourth day after birth. This sense is the last one to appear and the slowest to develop. Not until the fourth month can we ascertain that the child has normal hearing.

At birth the temporal bone is loosely connected with the other cranial bones. At this period the temporal bone is soft and spongy except the capsule of the labyrinth which, even now, is dense bone. The temporal bone gradually forms dense cortical layers, which at the close of the first year, are thin but quite solid. At first the temporal bone is very vascular and is traversed by many canals containing vessels which allow very free circulation of the blood between all the surfaces of the bone. The chief of these is the petro-squamosal foramen. The temporal bone can readily be divided into its petromastoid and squamo-tympanic parts, which are separated by wide sutures. The annulus tympanicus is firmly attached by its apices to the outer plate of the squamous bone. The petromastoid portion is still separated from the squamous by a cartilaginous plate, and the petrotympanic suture is wide open. Before the end of the first year, however, all the parts are united.

In the new-born infant, the mastoid antrum, measured from the tip of the short process of the incus, is about 8 mm. in length; the

adult antrum, measured in the same way, is about 11 mm. In the infant the walls are of spongy bone, and the outer wall, made up by the posterior process of the outer plate of the squama, is softer and thinner than the tegmen. (This fact explains the readiness with which pus escapes in this direction in infancy.) The mastoideo-tympanic suture is not united, and therefore allows subperiosteal escape of pus from the tympanum behind the posterior wall of the meatus. The mastoid process is not yet formed, but its future site is indicated by

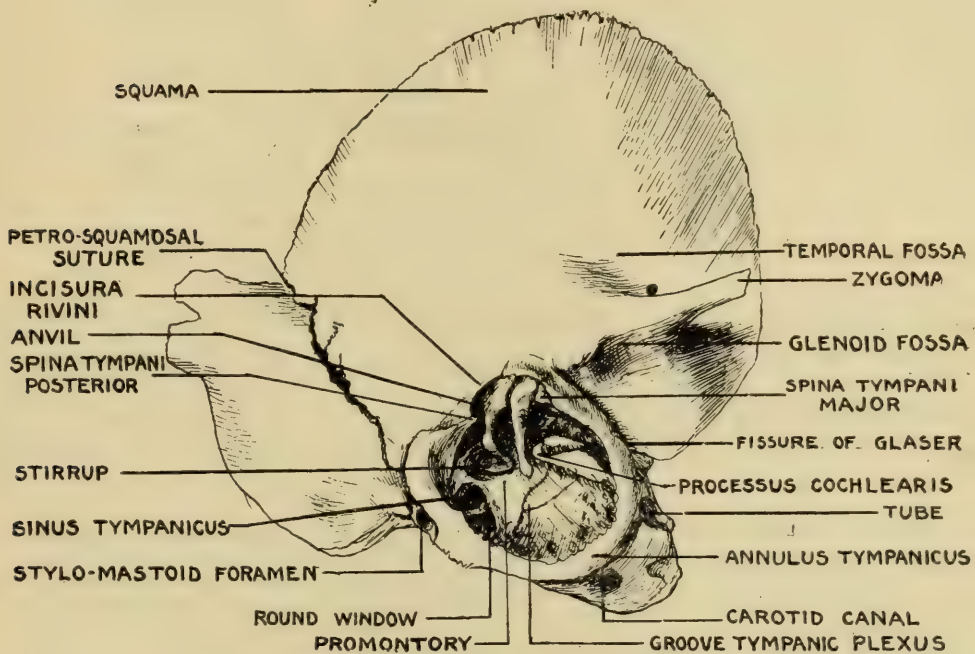


FIG. 194.—Outer View of Right Temporal Bone at Birth (enlarged).

a flat tubercle. The development of the mastoid process begins about the second year, after which it grows chiefly from an increase of diploe till near the time of puberty, when it grows rapidly and the air cells are completely developed. At birth the upper part of the antrum may be encroached upon by trabeculae enclosing cells. Small cells may appear in the base of the process as early as the third year. The groove for the sigmoid sinus becomes noticeable about the end of the first year, and its development is also completed at puberty. At birth, the sigmoid sinus is always placed well behind the tympanum and never approaches the meatus. The bone between the sigmoid sinus and the mastoid antrum is comparatively thick.

When the infant is born, the lower and outer walls of the facial canal are wanting where the canal crosses the tympanum above the oval window. The stylomastoid foramen, for the exit of the

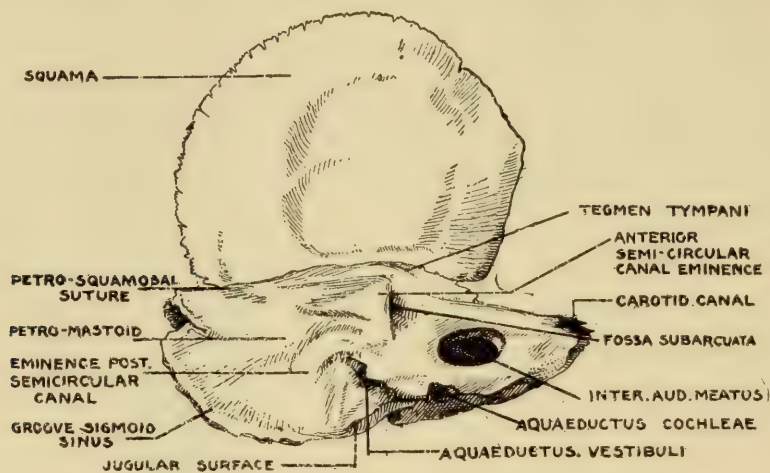


FIG. 195.—Inner View of Left Temporal Bone at Birth.

facial nerve, lies immediately behind the annulus tympanicus on the lateral surface of the temporal bone, not on the under surface as in the adult. This foramen is not deep beneath the tissues of the neck, as in the adult, but is superficial. The exposed position of the

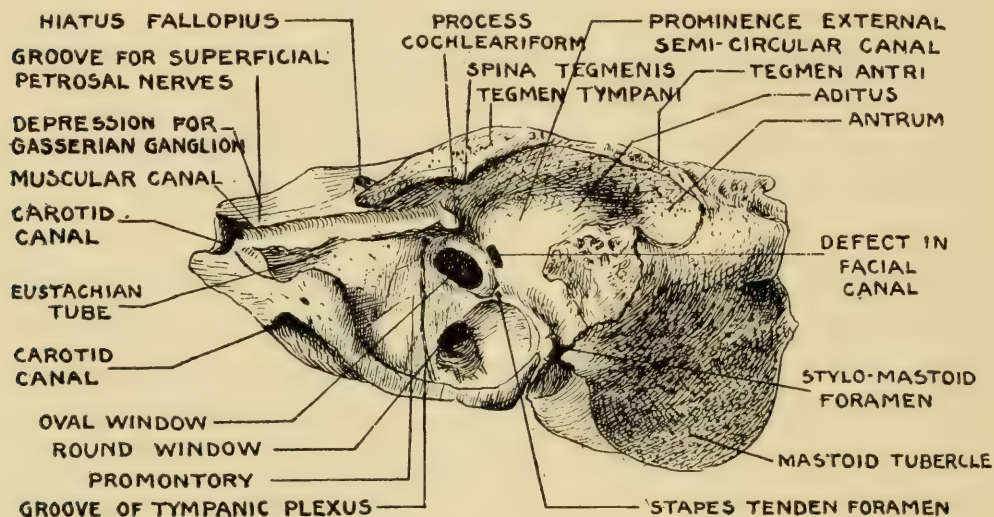


FIG. 196.—Left Petromastoid Bone at Birth, Outer Side. The Squamo-tympanic Bone has been Removed.

facial nerve at its exit from the stylomastoid foramen in the infant makes it especially liable to injury in the mastoid operation. There is no styloid process or digastric groove at birth.

The osseous Eustachian tube is also wanting in the infant. The tympanic cavity is about as extensive as in the adult, measuring 14 mm. parallel to the malleus handle. Sieve-like bone separates the floor of the tympanum from the carotid canal, and from the jugular bulb which is located directly below, and not behind the tympanum. The jugular fossa is not yet formed. The oblique position of the meatus and this thin plate of bone allows a puncture of the jugular bulb or carotid artery during tympanotomy. The osseous labyrinth, the ossicles, and the sulcus tympanicus are fully

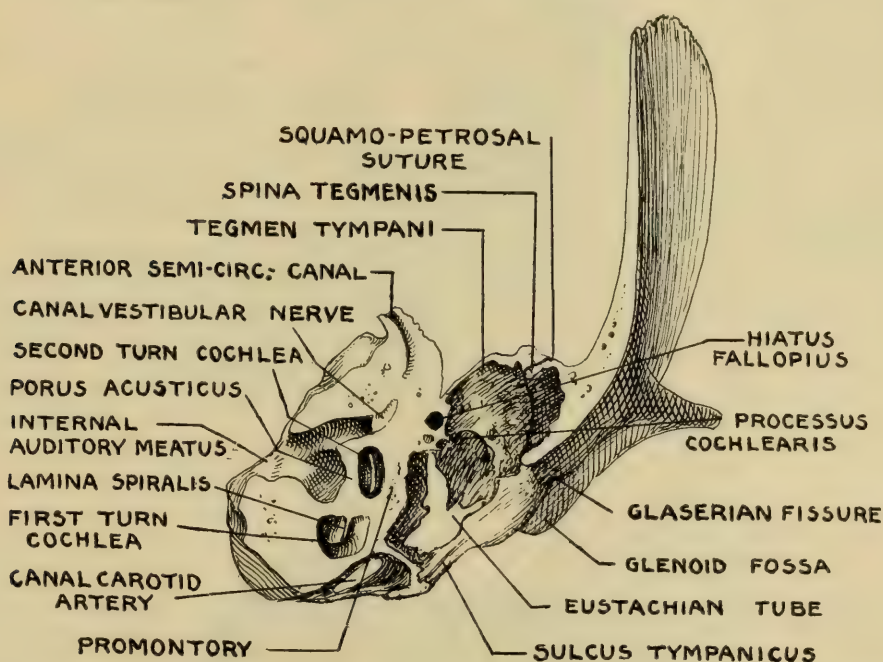


FIG. 197.—Vertical Section through the Meati, Anterior Half, Right Temporal Bone at Birth (enlarged).

developed, and, together with the facial canal, are in their permanent relative positions. The cavum tympani changes very little after birth, but its accessory cavities, the mastoid cellular system and the Eustachian tube, undergo development. The tympanic muscles also grow much larger.

The osseous external auditory meatus does not exist at birth, and the suprameatal spine has not yet been developed. During the second year the tubercles of the annulus tympanicus enlarge sufficiently to meet and enclose the foramen of Huschke in the tympanic plate, which gradually closes and is usually obliterated after the fifth year. Development of the whole temporal bone is complete soon after puberty.

The external auditory meatus measures at birth about 13 mm. on the upper wall and 19 mm. on the lower; the adult meatus about

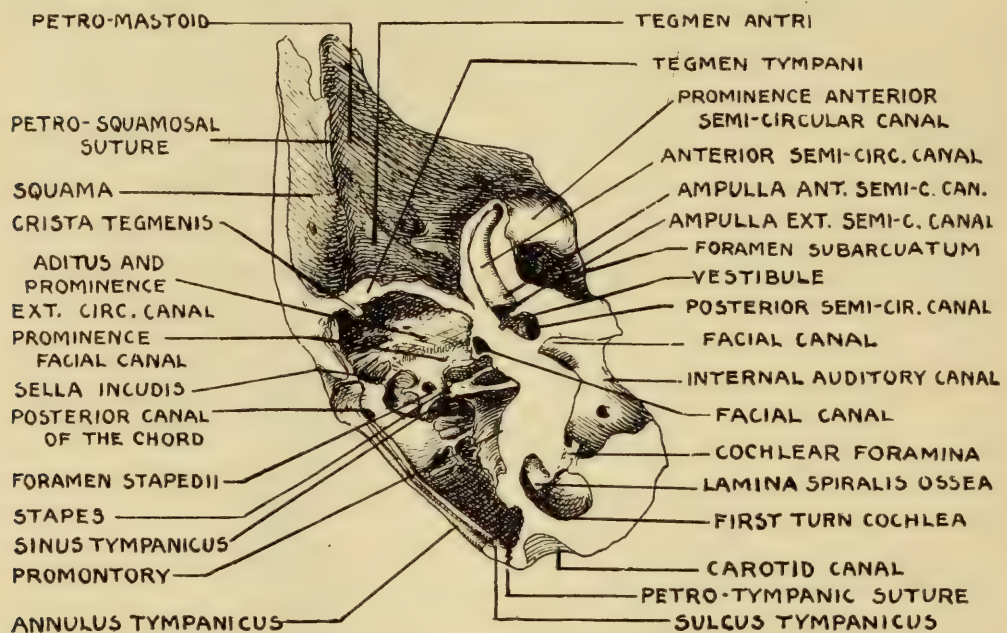


FIG. 198.—Same Bone as in Fig. 46, Posterior Half (enlarged).

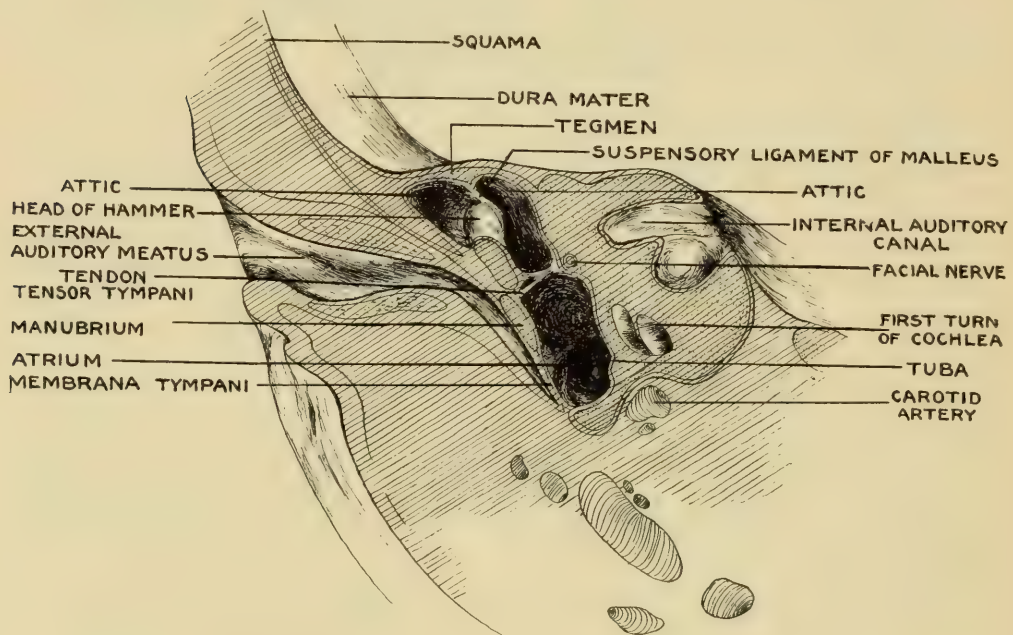


FIG. 199.—Vertical section of ear through meati; anterior half, left ear, infant. Shows the external meatus extending upward and outward; the hammer is cut across the neck, and a piece of the handle is seen in the membrane (enlarged).

29 mm. and 35 mm., respectively. The meatus is not closed by agglutination of its walls as in the young of lower animals, but there is a simple coaptation of the inferior and superior wall and the

membrana tympani with the inferior wall. The irregularities are filled with desquamated epithelium, consequently the lumen or air space of the meatus does not exist. In a few days after birth the meatus begins to open gradually, forming an hour-glass-shaped canal with a constriction corresponding to the isthmus of the canal of the adult. This canal, which is large at the inner end to fit the size of the annulus, retains foreign bodies with more tenacity than the adult meatus. The axis of the external meatus is directed

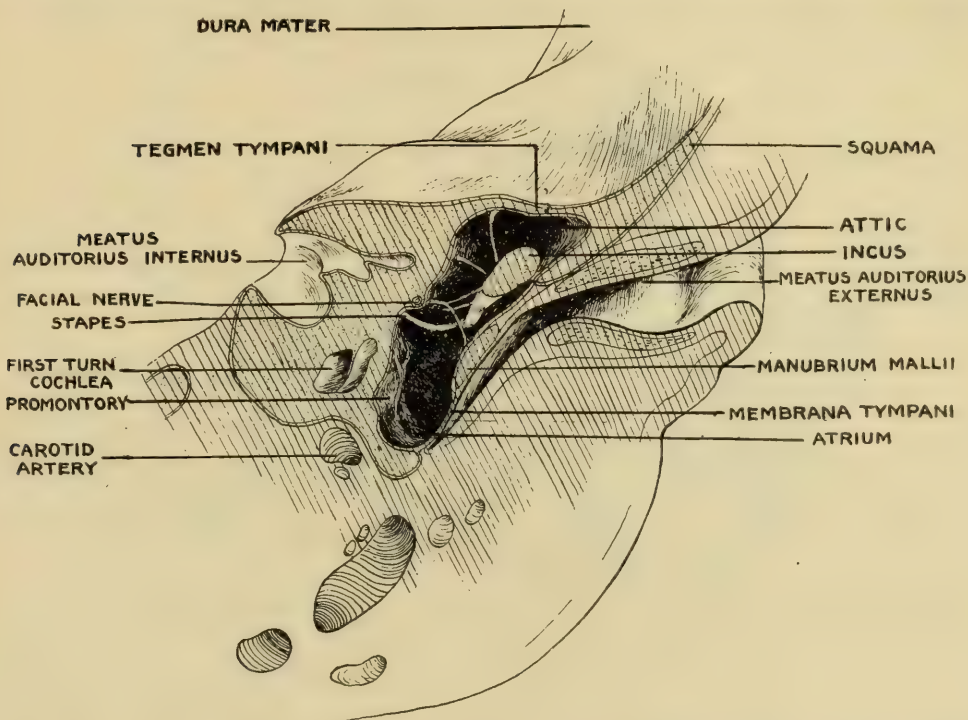


FIG. 200.—Vertical section of ear through meati, posterior half, left ear, infant. Shows the body of the incus cut, the tip of the handle of the malleus in the membrane; stapes in the oval window (enlarged).

slightly downward, which necessitates downward traction on the auricle to allow inspection of the membrane, and thereby causes the illusion that the membrane lies horizontally. At birth half the meatus is cartilaginous and half membranous.

In the infant the attachment of the auricle to the side of the head is proportionately more extensive than in the adult, thus placing the angle formed by the pinna and the side of the head far backward. The difference in position may be the cause of accidentally opening the fossæ of the skull, mistaking these for the antrum which lies anteriorly.

The Eustachian tube is narrower and much shorter in the infant

than in the adult. It measures about 20 mm. and in the adult about 40 mm. from the anterior border of the sulcus tympanicus. Its lumen at the isthmus is about half that of the adult tube, measuring about 2 mm. against 4 mm. in the adult. Unlike the adult tube, it lies in a horizontal plane, but its angle with the median plane is about 45° forward and outward, as in the adult. The tube assumes the adult position at puberty. The relative position of the pharyngeal orifice as regards the posterior pharyngeal wall and velum palati is farther forward and slightly lower down in the infant than

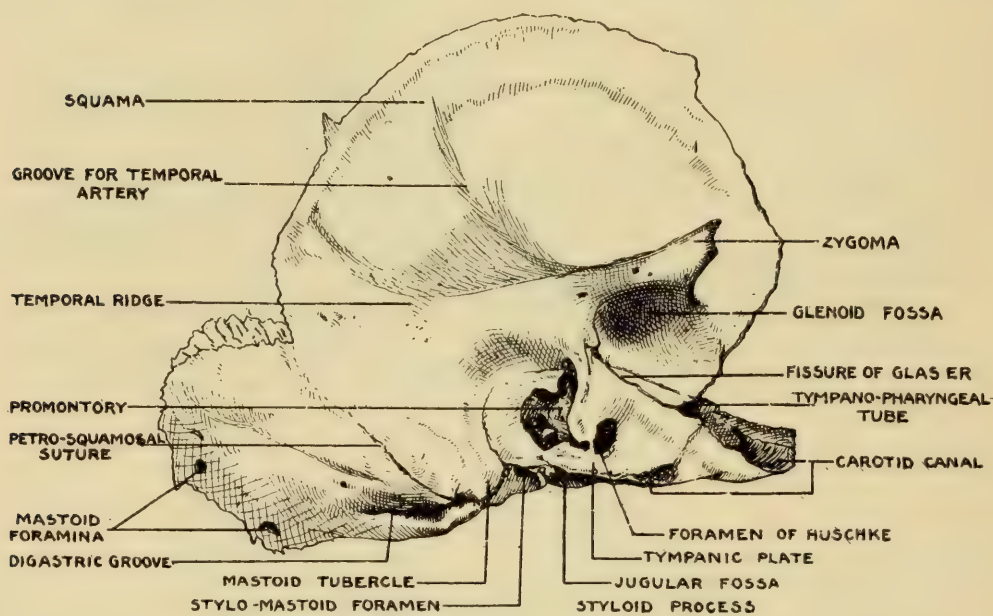


FIG 201.—External View of Right Temporal Bone of Infant One Year Old.

in the adult. The fossa of Rosenmüller does not appear as a deep depression until later in life.

The tympanic air cavity does not exist at birth, the osseous cavity being filled with myxomatous tissue and cellular detritus. It is not formed until several days later, when the air enters through the Eustachian tube. Still later, the air takes the place of the myxomatous contents of the mastoid antrum. The mucosa lining the cavum tympani and antrum has a very thick submucous layer, and in the cavum, a very uneven surface. The thickness of the submucous lining and the reduplication of the membrane cause considerable reduction in the size of the tympanic cavity and the mastoid antrum. In general, the tympanic cavity and mastoid antrum of the infant contain much more mucous membrane and more bony trabeculae

than those of the adult. In the adult these are reduced by an atrophic process. The contents of the tympanum proper are fully developed at birth. The drum membrane at birth is the same size as in the adult.

It is worthy of note that the lymphatics of the infant show a more important difference in comparison with those of the adult than any of the other structures. It is peculiarly significant that the

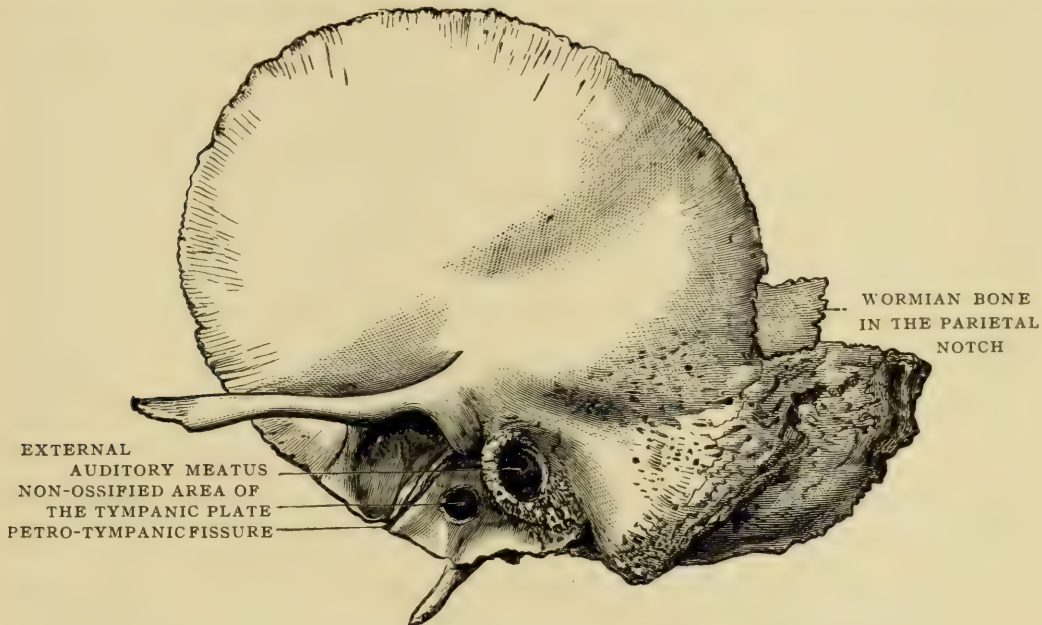


FIG. 202.—Temporal Bone at the Sixth Year (Morris).

infantile lymphatics are nine times more permeable than those of the adult. The length of the lymphatics from the ear to the mediastinum in the infant is about one-ninth that of the adult lymphatics—2.5 cm. to 18 cm. The caliber, however, is the same. These dimensions allow the transmission of bacteria to the mediastinum nine times more readily than in the adult.

PHYLOGENESIS.

The phylogenesis of the vertebrate ear shows clearly that the ear of man is a development of the undifferentiated ectoderm, which was the primitive organ of sense. The perception of sound begins by being merely the general tactile or pressure sense-perception of vibration. (This tactile appreciation of sound is not lost throughout the zoological series, not even in man.)

The Morphological Development of the Labyrinth.—Certain portions

of the sensitive ectoderm became differentiated for the purpose of more highly-developed perception of certain stimuli, such as the molar movements of the circumambient water. This part of the skin then became the lateral line canal organ of the fish. This canal organ becomes still further specialized for the perception of molar motion by the development of neuro-epithelium, and by adding sand particles to the water in the canal. These sand particles impinge more forcibly on the hairs of the neuro-epithelium than could the water. The sand particles also furnish a means for the perception of the direction of gravitation. This canal organ develops into the primitive labyrinth. The first change of this canal organ is a specialization of part of the canal which retains openings at both ends to the surrounding water. This tube develops a pouch, and divides into the utricle and saccule, each half developing semi-circular canals, which are always at right angles to each other. The utricle and saccule retain the original external openings of the canal, which become the endolymphatic ducts. Later, the utricle loses its endolymphatic duct. Still further on in the series, the saccular duct becomes closed externally, and calcareous concretions, called *otoliths*, take the place of the original sand otoliths.

Functional Development of the Labyrinth.—The primitive labyrinth had an undifferentiated power of perception of molar and molecular motion. The organ for the perception of molar motion became more highly specialized, forming the peripheral organ of equilibration, which is situated in the vestibule and the semicircular canals. In the higher reptiles the differentiation of a portion of the labyrinth appeared for the better perception of the molecular or sound motion. Thus was developed the legena, the parent of the cochlea. The cochlea still retains the characteristic of being a pressure organ. As the labyrinth becomes differentiated and specialized in its structure, the otoliths are less extensively distributed, and the sensory epithelium or hair cells become less numerous, but more highly differentiated.

It is interesting to note that the peripheral space organ, or the organ of equilibration is formed on the same plan throughout the animal series, namely, that of a sensitive sac containing one or more otoliths. The only important variation is the source and number of these otoliths. In most cases, these bodies are found in a closed sac; in some species, as in the lobster and spiny dog-

fish they are fine particles of sand placed in specialized cups by the creature itself.

Development of Perilymphatic Sac.—The perilymphatic sac is developed from the large lymph spaces surrounding the lateral line canal. The legena organ is highly developed among the alligators and crocodiles, and more highly in the birds. The cochlear development of the legena does not appear until we reach the mammals. The cochlea is the only part of the ear which serves for sound-perception alone.

Development of the Tympanum.—The drum membrane and its ossicular connection with the labyrinthine fluid were made necessary when the animal became an air-breathing amphibian, in order to facilitate the difficult transmission of sonorous vibrations from the rarer medium of the air to the denser medium of the labyrinthine fluid. The ossicular connection traverses a space called the cavum tympani. The number of ossicles varies from one to three. Their proportionate size and the shape of the cavum varies in different genera.

The air space of the tympanum was at first made to provide space in which the drum membrane could vibrate. In the lower types, these spaces did not extend beyond the membrane, and the ossicular connections were covered by mucous membrane. There were no air cells, such as the mastoid cells. Later on, the mucous membrane became less abundant, and cells were developed communicating with the tympanic cavity. The ossicles were more or less free in the cavum tympani. In man, the ossicular chain seems to be undergoing a change from being partially covered to being wholly free from the folds of mucous membrane.

Development of the External Ear.—The auricle is a device for collecting aerial sound waves, and this mechanism first appears in the terrestrial mammals. In man the auricle is a degenerate organ, inasmuch as it has lost all practical power of motion in order to collect or locate sounds. The muscular apparatus is usually present, but is functionally deficient. In many of the lower animals the auricle has considerable mobility which enables its possessor to collect a greater volume of sound and to determine its direction.

Not until we reach the mammals do we find the essential type of the human labyrinth with its three semicircular canals, utricle, saccule, and cochlea, and the external canal and auricle.

EMBRYOLOGY AND ONTOGENY.

The otic vesicle, which later forms the endolymphatic structure, develops at an early age from the ectoderm at the dorsal termination of the first visceral cleft. The counter of the complete endolymphatic sac is formed by the growth of special parts of the original vesicle, by infolding, and by the disproportionate rate of development of the walls. The cochlea, which begins as a short pit, becomes elongated and curves into a spiral. The neuro-epithelium is formed by a special development of certain areas of the epithelium lining the otic vesicle. The perilymphatic sac is formed from enlargement of the lymph spaces surrounding the endolymphatic sac or the vesicle.

The acoustico-facial ganglion is developed on the dorsum of the hind brain, close to the otic vesicle. The ganglion first divides into the facial and acoustic ganglia. The acoustic ganglion, in turn, subdivides into two ganglia, one connecting with the neuro-epithelium of the cochlea and the other with the neuro-epithelium of the vestibule and semicircular canals. The enveloping petrous portion or the labyrinth capsule is developed from the mesoderm, which surrounds the otic vesicle.

The tympanic cavity and its appendages are formed from the endodermal layer of the first visceral cleft, by evagination and by increased development of certain parts. The mesodermal layer surrounds this evaginated cavity. The hammer and anvil are formed from the first visceral arch which also forms part of the tympanum. The stirrup and the stapedius muscles are developed from the second visceral arch. This arch meets with the first to form the roof of the tympanic cavity.

Near the end of fetal life the mucosa of the pharynx follows the spaces left by spongification and absorption of the matrix about the ossicles and covers these spaces and the other tympanic structures with mucous membrane. The mastoid antrum and later the mastoid cells are formed by evagination of the mucous lining. The tympanic membrane and external ear are formed from the ectodermal groove of the first branchial cleft. The ectodermal layer of the external meatus is evaginated inward and the endodermal layer of the middle ear outward. The drum membrane is formed at the place where these layers meet.

The pinna is developed from the posterior edge of the first, and the anterior edge of the second branchial arches. The centers of ossification for the different parts are quite numerous. Shortly before birth the bony structure is composed of three parts—the petromastoid, squamous, and tympanic or annular tympanicus.

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CHAPTER XXVI.

PHYSIOLOGY. THEORY OF SOUND PERCEPTION. TONE AND NOISE
PERCEPTION. PHYSIOLOGY OF SOUND CONDUCTION. PHY-
SIOLOGY OF THE DETERMINATION OF THE DIRECTION OF
SOUND. TACTILE SENSE OF SOUND PERCEPTION.
PHYSIOLOGY OF EQUILIBRATION. PROTECTIVE
MECHANISM OF THE EAR.

THEORY OF SOUND PERCEPTION.

In the fourth century, B. C., Empedocles referred the auditory impressions to the cochlea. From his time until the time of Helmholtz there was no marked advance in the theory of sound perception, the general explanation of the phenomenon being on a tactile or pressure basis.

Helmholtz found a very fertile suggestion for a basis of his theory of sound perception by sympathetic vibrations in the description of the cochlea as a sound-perceiving mechanism with a basilar membrane containing fibers, whose length varied successively, from the longest at the apex of the cochlea to the shortest at its base.

This explanation of the arrangement of the basilar fibers, which was made by Hensen, Helmholtz made the foundation of his final theory, which is called the "piano-string theory" of sound perception. His theory is, briefly stated, that each basilar fiber responds sympathetically to a definite tone, and stimulates the hair cell of the neuro-epithelium of Corti's organ which rests upon the fiber; and that the nerve impulse from this stimulation of the hair cell is carried to the brain as a stimulation of a definite cell corresponding to a definite note. The higher tones, according to Helmholtz, are perceived at the base of the cochlea, and the lower tones at its apex.

The objections to this resonance theory of Helmholtz are:

The phylogenetic development of the mammalian ear from the lowest vertebrate ear shows nothing of a sound-selecting device corresponding in any way to Helmholtz's supposition with regard to the human cochlea.

The next objection is an anatomical one, namely, that there are not enough fibers and they are not of the various relative sizes required to respond to all audible notes. The structure of the basilar membrane is a basement aponeurotic membrane with fibers running transversely and longitudinally, and covered with relatively thick masses of cellular tissues and blood-vessels. Fibers in such a mass could not vibrate individually, and therefore could not vibrate sympathetically to any tone.

The so-called *sensitive hair theory* seems to the author to be the most plausible and most satisfactory explanation of the phenomenon of sound-perception. Briefly stated, the theory is: A sound wave after it has been transmitted through the external and middle ear, and has entered the labyrinthine fluid, beats upon the sensitive hair band, formerly called the tectorial membrane. *These long sensitive hairs appear to the author to be the means of the transmission of the sound wave impulses to the neuro-epithelial cells.* The sound waves pass over these sensitive hairs in much the same way as wind passes over a corn field. The motion of the hairs thus caused is transmitted down the hair to the neuro-epithelial hair cell which transforms it into a nerve motion and the perception takes place in the higher centers of the brain, the sound waves not being analyzed in the cochlea as is generally supposed.

This sensitive hair-theory is based on the phylogenetic and ontogenetic development, and upon the histological structure of the organ of Corti.

Let us first consider the phylogenetic development of the organ of Corti.

The organ of sound-perception, or the organ of Corti, is merely a specialized portion of the general tactile sense organ of the lowest vertebrates, without any special sound-selecting power.

In the tunicates, and even in the lowest of the vertebrate series, the tactile sense alone perceives molar and molecular motion of the surrounding aqueous medium. The first advance toward a differentiation of function appears in the fishes where the lateral line canal organs first appear. These organs are formed by invagination of the cuticular layer and are provided with clumps of specialized sensory epithelium. Because of this specialized epithelium and because of the canal form, these organs have a more highly developed power of noting the molar and molecular movements of the cir-

cumambient aqueous medium than the undifferentiated surface of the body.

There is very strong evidence to justify the statement that, as specialization advances in the ascending series, a part of this canal system is set apart and endowed with still more delicate and specialized power of molecular movement-perception, a definite tone-perception. This change is brought about first by the separation and enclosure within the head of a specialized portion of the canal organ which has now become a labyrinth.

The legena first appears in the fishes. The labyrinth is further specialized in the higher reptiles and birds by the greater development of the legena with its papilla basilaris. Still further specialization takes place in the mammals by the development of the legena into the cochlea with its organ of Corti.

To go back to the primitive condition of the lateral line canal organ, we observe that certain of the epithelial cells are specialized and furnished with filaments or hairs which facilitate the perception of the molar and molecular motion of that part of the circumambient fluid which circulates in the canals. This hair-bearing epithelium persists throughout the vertebrate series, changing only in grouping and in its increasing specialization, and continues to be bathed by the fluid which in the higher forms is enclosed within the labyrinthine capsule. The function of the epithelium also continues to be the same, except for the specialization of certain groups of the hair-bearing epithelial cells adapted to the perception of special forms of molar and molecular motion. The epithelium that concerns us in sound perception, while it is specialized for the perception of molecular wave-motion or sound vibrations, has not lost its primitive type.

The ontogenetic development of the organ of Corti proceeds along parallel lines to the phylogenetic development.

Histological Structure of the Organ of Corti.—There are several highly specialized portions of the labyrinth of the higher vertebrates which have long baffled investigators and have long been subject to misinterpretation. The organ of Corti alone concerns us as specialized for sound perception, but by the help of the others, we can make our point clearer.

In mammals, the epithelium of the cristæ and the maculæ acusticæ are provided with long hairs. For a long time the relation of the

hair and the hair cells of the cristæ and the maculæ acusticæ in the lower forms was misunderstood, owing to the condition in which the histologists found the hairs. They appeared transformed into a mass which at first was called a tectorial membrane or "cupola" from its shape. Finally it was proved that the tectorial membrane or cupola was really made up of the bulk of the hairs of the neuro-epithelium, and that the reagents employed in the manipulation had made this artifact of them. More recently it has been proved that the tectorial membrane of the papilla basilaris legænæ in reptiles and birds, and later still the tectorial membrane of the organ of Corti in mammals, are artifacts similar to the cupolas, and really are an amalgamated mass of hairs of the neuro-epithelium. These structures have been shown to be extremely susceptible to alteration from chemical reagents. The distorted appearance of the hairs making up the tectorial membrane and the errors in the observations were due to the fixing and staining reagents to which they were submitted. The hairs and the hair cells of the organ of Corti exhibit no special change from the hair cells of the legænæ.

The histological proofs of these facts have been worked out by following the developmental series, beginning at the lowest mammals and noting the persistence of the hairs when no reagents were used, and their disappearance after the use of reagents. Professor Howard Ayer deserves the credit for establishing these facts.

Conclusion.—These phylogenetic, ontogenetic, and histological investigations coincide to prove that the so-called tectorial membrane of the organ of Corti is an artifact of the long hairs of the neuro-epithelium of the organ of Corti, and that there is no structure which has a tone-selecting function.

Will this theory of the undifferentiated sound-perception by means of the sensitive hairs fulfil the acoustic requirements? We find that it will, and better than any other theory and for the following reasons: Every property of a sound wave is shown in the characteristics of the wave front; these characteristics are variations in the curve of the wave, and we find that they are transmitted in every particular to the hair band.

Every property of the sound wave is represented in the form of the wave. Every character of the wave form is imprinted upon the sensitive hairs of the neuro-epithelium of the organ of Corti. The

neuro-epithelium transforms the molecular sound vibrations into nerve impulses which are interpreted by the brain.

The sound waves which enter the labyrinth from the middle ear in man, enter the perilymph, pass through the membranous walls of the scala media, and beat upon the long, delicate hairs of the organ of Corti, without any mechanism for the differentiation of special tones, just as they did on the maculæ acousticæ of the fish, or the sensory tufts of the lateral line organ.

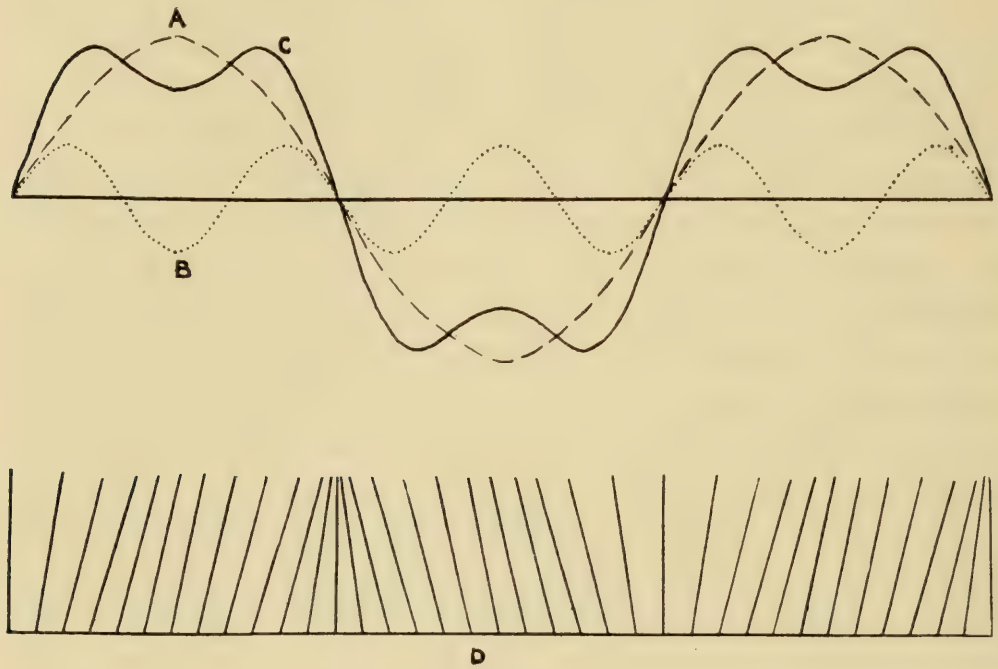


FIG. 203.

a, Curve of fundamental note; *b*, Curve of second Overtone in same phase; *c*, Resultant curve, the regularity of which indicates harmony; *d*, The hairs of the organ of Corti acted upon by the resultant curve *c*.

Each individual hair has a definite position for each instant of the wave, which position it occupies only once during the oscillation. It does not return to this position until it reaches the corresponding instant in a succeeding wave.

The impulses received from the hairs of the organ of Corti are transmitted to the cochlear nerve endings, and the cochlear nerve carries the stimulation to the auditory center in the first and second convolutions of the temporal lobe of the brain. The hair cells transform the molecular sound motion into a nerve motion which the brain interprets. The accuracy of the analysis of the sound is proportionate to the education of the individual in the matter of tone perception.

The cochlear nerve has extensive and important central and

cortical connections. It is chiefly connected with the higher centers in the cortex, but also has connections with the lower centers where it stimulates the reflex centers for appropriate automatic movements. The cortical connections of the cochlear nerve through the auditory sensory center are with the special centers whose complicated functions and intricate connections comprise the complex structure of the intellectual mechanism. The lower connections of the cochlear nerve are with the nuclei of the seventh cranial nerve and with the nuclei of the third, fourth, and sixth cranial nerves. These connections explain the reflex movements of the face and eyes associated with auditory stimulation. There are also connections, but less definite, with the motor tracts of the spinal cord and cerebellum and with the great sensory and motor tracts of the brain.

TONE PERCEPTION.

The perception of sound includes the perception of tone and noise.

Tone.—The essential characteristic of tone is that it is composed of even impulses which recur with the regularity of a pendulum. The three properties of tone are intensity, pitch, and quality.

Intensity is the term used to denote the relative amplitudes of the sound waves.

Pitch is the term used to denote the relative rates of vibrations of different notes. Slow vibrations cause notes of low pitch, and rapid vibrations cause notes of high pitch.

Quality is the term used to denote the different auditory effects of the same notes emanating from different sources. It depends upon the varying combinations and intensities of the accompanying overtones.

The combination of two or more musical tones effect either harmony or discord.

Harmony is the combination of tones having rates which are equal multiples of each other and which form an even resultant wave.

Discord is produced when several notes are sounded whose rates are not whole multiples of each other.

Tone Limits.—When regularly recurring waves or impulses occur slower than the rate of vibration of the lowest audible tone, the ear perceives them as distinct shocks. If the impulses increase in

rapidity, the intervals between the integral stimulation of the auditory nerve shorten until finally the irritation of the nerve becomes continuous. The lower tone limit is found at the instant when the ear perceives the lowest audible tone, which is about twenty-eight single vibrations per second. When the rate of vibration increases, the tone becomes higher and higher pitched until it is no longer perceived at the upper tone limit. The upper tone limit is about 100,000 single vibrations per second.

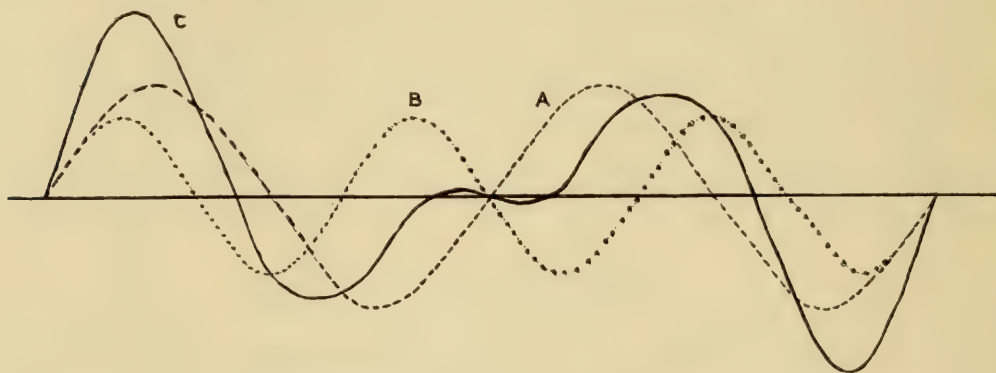


FIG. 204.—The Diagrammatic Curve of a Discord.

a, Fundamental tone; *b*, A tone whose rate is one and one-half times more rapid than *a*. They start in the same phase, but soon irregularities and unevenness occur. These indicate discord. *c*, The resultant curve of *a* and *b* shows these irregularities. Beats are formed which recur with a rate one-half that of the fundamental *a*.

Noise.—When the pulses or vibrations are irregular or uneven they are perceived as distinct shocks. When their rate of recurrence increases sufficiently for them to cause a continuous stimulation of the auditory nerve, they produce noise. A noise is usually composed of many vibrations of different wave lengths sounding simultaneously, like the rattling of a cart.

Noises are probably perceived to some degree by all parts of the labyrinth. The perception of tone as such is confined to the cochlea, the papillaacustica, or organ of Corti, being the structure concerned in this sensory function.

PHYSIOLOGY OF SOUND CONDUCTION.

An important appendage to the labyrinth is made necessary for the continued perception of sound when the animal goes from the original denser aqueous medium into the rarer gaseous medium of the atmosphere. The conduction of sound waves from a rarer to a

denser medium encounters an almost insurmountable obstacle in this change of medium. This transmission is necessary because the sensory epithelium continues to be bathed in the dense endolymphatic fluid. This obstacle is surmounted by the development of the mechanism of the middle ear. This sound-transmitting mechanism is capable of collecting the diffuse sound waves of the rarer gaseous medium and focusing them sufficiently until their increased power allows them to pass into the labyrinthine fluids in the form of condensed waves of the denser medium. When once in the labyrinthine fluids the sound waves proceed as they did in the primitive labyrinth or canal organ found in the fish.

PHYSIOLOGY OF AIR CONDUCTION.

The mechanism for sound conduction focuses the wave impulses by the relatively smaller area of the inner end of the mechanism.

Sonorous vibrations, transmitted through the air as sound waves, strike upon the concha, and are reflected against the tragus, which in turn reflects them into the external canal. The external canal directs these waves against the drum membrane. The drum membrane and ossicles are in a very delicate state of equilibrium called the acoustic balance, ready to respond to the most delicate impulse. This mechanism is set in vibration corresponding to the sound waves of the air which have penetrated to the bottom of the canal. The waves of sound which impinge on the membrane pass on through the handle of the hammer, through the chain of ossicles, and enter the perilymph from the foot-plate of the stapes.

The sonorous vibrations are transmitted through the apparatus of the middle ear as a mass movement, as oscillations of the separate ossicles, or as a molecular movement. For tones of slow rate of vibration and of greater amplitude, the transmission is by means of mass or individual motion of the ossicles; for higher tones, tones of less intensity, the motion is molecular. In either case close apposition is required of the ossicles for perfect sound transmission. The drum membrane, the chain of ossicles, and the labyrinthine fluids vibrate as a single body of varying density through which the sound waves pass from end to end.

A small amount of sound passes directly through the tympanic membrane and the enclosed air chamber of the tympanum, and

impinges on the membrana tympani secundaria of the round window, the foot-plate of the stapes, and the outer wall of the labyrinth through which the waves, much reduced in intensity, pass to enter the labyrinthine fluid. The construction of this composite sound-conducting mechanism—composed of the concha, external canal, drum membrane, ossicles, perilymph and endolymph—is especially adapted to take up vibrations of the air over a large area and to transmit them to the perilymph over a small area. This mechanism receives a sound wave of lesser intensity and greater amplitude in a rarer medium, and transmits it as a wave of greater intensity and lesser amplitude in a denser medium. The force of the impulse transmitted to the perilymph from the air is increased thirty times, and the amplitude diminished seventy-six times or more. The apparatus for the conduction of sound begins in the concha and ends in the hair cells of Corti's organ.

The physiology of the transmission of sound by the drum membrane depends upon the concavo-convex surface and the highly elastic structure of the drum membrane. The drum membrane is made of radiating and concentric fibers combined in such a manner as to render it extremely sensitive to sound vibrations. For the maintenance of this sensitiveness, it is necessary that the tension of the membrane should be in perfect equilibrium, and not weighted by unequal air pressure on either of its surfaces, or by unbalanced tension of the ossicles.

In the erect position the center of gravity of the ossicles falls to the outer side of the axis of their motion, the weight of the drum membrane and its tension on the inner side of this axis, thus counterbalancing each other. The whole sound-conducting apparatus of the middle ear is constructed in such a way as to facilitate oscillation, but at the same time to prevent pendulum movements. The mechanism is easily moved from its position of rest, but on the return swing does not tend to pass beyond the center.

Movements of the Ossicles. The hammer swings on an axis which passes through the processus gracilis in front. The incus swings on an axis which passes through its short process behind. These two axes meet in the incudomalleolar articulation. Both bones swing as one on this axis. When the handle of the hammer is drawn inward, the head of the hammer and the body of the incus, placed over the center of oscillation, are moved outward. If the drum

membrane moves outward, it carries with it the handle of the hammer, but owing to the form of the articular surface of the incus, the incus is moved very little and still less motion is transmitted to the stirrup. When the hammer handle swings inward, the long process of the anvil goes inward also, because the hammer and anvil lock, and the stirrup is pushed inward against the oval window.

The contraction of the *musculus tensor tympani*, which draws the hammer handle inward, increases the tension of the drum membrane. The joint between the larger bones is locked and the anvil is moved inward; the long process swings inward, pushing

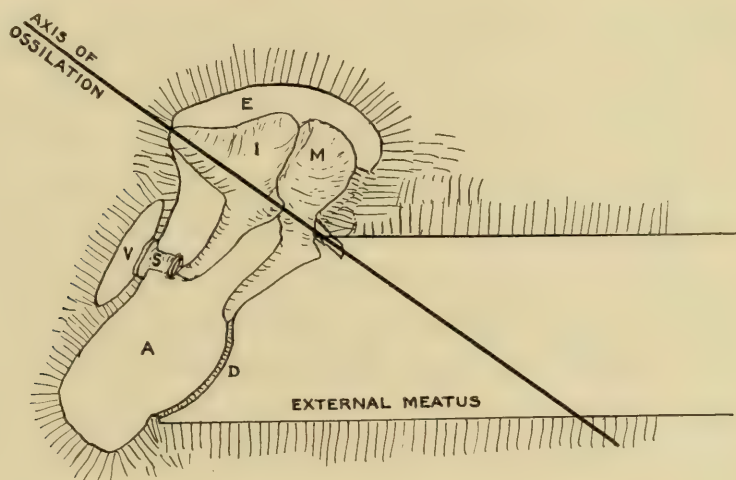


FIG. 205.—Diagram Showing Acoustic Balance, and Axis of Motion of Ossicles.

a, Atrium; *d*, Drum Membrane; *e*, Epitympanum; *i*, Incus; *m*, Malleus; *s*, Stapes; *v*, Vestibule.

the stirrup ahead of it. Contraction of the *musculus stapedius* tilts the foot-plate of the stapes outward, and swings it on its lower posterior margin which is the fulcrum for all its movements.

The ossicular chain, by holding the membrane tense, serves to maintain the acoustic balance of the drum membrane; and by increased tension or by relaxation, accommodates the membrane for the better reception of certain sounds.

Combined contraction of both the tympanic muscles raises the low tone limit, lowers the upper limit of tone perception and decreases the duration of sound perception.

Accommodation of the sound-conducting mechanism is brought about by the contraction of the tensor tympani muscle. This muscle is both accommodative and protective in its action, while

the stapedius muscle is only protective. Contraction of the tensor tympani muscle increases the tension of the drum membrane and locks the articulation of the major ossicles, thus facilitating sound transmission, especially for vibrations of short wave length. Contraction of the stapedius muscle pulls the stapes from the oval window and antagonizes sound transmission by weighting the stapes and at the same time holding it away from the oval window.

The folds of mucous membrane in the cavum tympani and the bone trabeculae and cells, serve to dampen the intratympanic air-borne sound waves, and thereby to prevent reverberation in the cavity.

The function of the mastoid cells has nothing in common with the physiology of hearing; the cells serve only to lighten the bone structure. The mastoid cells are most abundant when the bones are highly developed, as in a large muscular man.

The physiological function of the tympanic pharyngeal tube is primarily to preserve the manometric balance of the drum cavity with the outside air. This is necessary in order that the drum membrane shall not be weighted on either side by air pressure and shall continue to possess the equilibrium necessary for the acoustic balance. The tube, while at rest, is barely closed at its pharyngeal orifice, so that the least pressure from within or without will force air through it.

The tympano-pharyngeal tube differs from the ventilator of the military drum in the fact that it is closed most of the time, whereas in the military drum the aperture remains open. This closure of the pharyngeal tube is necessary for good hearing, because the condensation and rarefaction of the air in the naso-pharynx during expiration and inspiration would disturb the acoustic balance of the drum head and prevent its proper action. With an open tube, tinnitus is caused by movements of the drum membrane consequent on alternating condensation and rarefaction of the air in the tympanum.

During the act of swallowing or gaping the contraction of the levator palati muscle pushes the angular process back of the alar cartilage of the tube. The cartilage swings backward, upward, and inward in the fossa of Rosenmüller. At the same time the contraction of the tensor palati gives a rigid support to the anterior wall of the tube, while the motion of the alar cartilage draws the

posterior wall backward. The lips of the pharyngeal ostium separate at the lower commissure, forming a triangular orifice and obliterating the rugæ of the tube.

The secondary function of the tympano-pharyngeal tube is drainage of the tympanic cavity. The ciliated epithelium of the tube accomplishes this tympanic drainage. The cilia of the tube receive the detritus of the natural metamorphoses of the lining membrane, or the products of inflammation which are delivered to it by the ciliated epithelium of the cavum, and waft them along the tube until they are discharged into the vault of the pharynx.

PHYSIOLOGY OF BONE CONDUCTION.

Besides being able to enter by the fenestra ovalis, the sound waves may pass through the tissues of the body and reach the labyrinthine fluid through the wall of the bony labyrinth. The sound transmission is much less perfect by this latter route and, on account of the mechanical disadvantages, it requires a much more intense aerial vibration to excite the auditory organ in this way.

SOUND TRANSMISSION IN THE COCHLEA.

The sound waves transmitted by the foot-plate of the stapes pass chiefly through the perilymph of the scala vestibuli, and through Reissner's membrane, to enter the scala media and strike against the hairs of the papilla acustica. Sound waves transmitted by bone conduction probably enter the perilymph of the scala tympani and vestibule and the endolymph of the scala media with equal intensity. The sound waves, which have entered the scala tympani may reach the organ of Corti through the basilar membrane and endolymph or through the helicotrema, Reissner's membrane and endolymph. The surplus energy of the sound waves entering by the stapes passes on through the helicotrema or through the basilar membrane into the scala tympani, and thence out through the membrana tympani secundaria, the latest development of the labyrinth.

PHYSIOLOGY OF THE DETERMINATION OF THE DIRECTION OF SOUND.

Mon-aural hearing receives waves of sound from all directions without any differentiation. It requires rotation of the head to locate the source of the sound. This movement serves to determine the direction from which the greatest intensity of sound proceeds. Mon-aural hearing, therefore, unaided, cannot determine direction of sound. Bin-aural hearing gives lateralization only, while it requires movement of the head—or of the ears, as in animals—to determine more definitely the direction of the sound. Movement of the sounding body serve to locate its position. Hearing is best at right angles to the axis of the concha. Consequently, the direction from which sounds are best heard by an individual ear depend upon the shape of the ear and upon the angle which the axis of the concha makes with the head. The direction from which the concha receives the greatest volume of sound waves is the direction of best hearing.

The reason the mouth is opened in intense listening is to lessen the respiratory sounds and open the mouth of the external auditory canal by forward motion of the jaw. The increased tension on the anterior wall of the canal, due to the forward motion of the condyle of the jaw, causes increased tension of the drum membrane, which aids the sound-transmission in certain cases.

The tactile sense of sound perception is present in all animals. The undifferentiated tactile sound perception exists also in man to a marked degree. The sense can be highly developed as shown in some blind deaf mute geniuses who can perceive and carry on conversation by the tactile sense alone. (This fact should be borne in mind when testing the labyrinthine sound perception of extremely deaf persons who may perceive sound by tactile sense and thus mislead the observer.) The tactile sense of vibration has practically no low limit; the normal high limit of tactile perception is between 4,096 single vibrations and 8,192 single vibrations.

PHYSIOLOGY OF EQUILIBRATION.

The peripheral impressions which serve to maintain equilibrium and to coordinate movements are derived from the viscera, the

skin, the muscles, the eyes, and—most important—from the vestibular apparatus of the labyrinth, which is the peripheral organ of equilibration.

The peripheral organ of equilibration has several distinct functions which are divided between two distinct groups of organs, the vestibular system proper, and the semicircular canal system. These functions are: 1. geotropic, 2. static, 3. cyclometric, 4. geometric.

The mechanism of equilibration is a very complicated contrivance made up of peripheral and central portions. The central part of the mechanism is formed by the association of the sensory nerves from the peripheral portions of the mechanism in the lower centers of the central nervous system. Here these nerves are brought into communication with the motor center governing the muscular system, which is the dynamic portion of the mechanism.

The peripheral space organ, the vestibule and its appendages, which are pressure organs, take cognizance of the direction of gravity and of movement in space. They depend, for their physiological action, upon their tactile perception of gravity, inertia, and friction. This physiological action is produced by the otoliths and endolymph. The specialized neuro-epithelium of the vestibule which lies on the maculæ of the saccule and utricle, is provided with sensitive hairs upon which the otoliths rest in a mucoid substance. The stimulation of this epithelium is brought about by the attraction of gravitation, which draws the otoliths downward most forcibly against the lowest hairs. The sensations are interpreted by the subconsciousness in the lower nerve centers as indicating the lowest and, by comparison, the highest parts of the vestibule. These data show the direction of gravity, which the higher centers interpret as up and down. All co-ordinated movements are performed accordingly. Should a movement of the body in a straight line be inaugurated, the inertia of the same otoliths will compel them to press most forcibly in the opposite direction to the motion. This stimulation is interpreted by the brain as indicating the inauguration and direction of the motion. When the inertia of the otoliths has been wholly overcome, they cease to stimulate the sensory epithelium except by their weight.

The otoliths, besides stimulating the geotropic sense of gravity, assist in the geometric sense of direction of motion, in the cyclometric sense of degrees of revolution, and in the static sense of commence-

ment and cessation of motion. Continued rotation can only be perceived through the intervention of the mechanism of the otoliths and their centrifugal action, since the mechanism of the semicircular canals ceases to act when the inertia of the endolymph has once been overcome.

The sense of movements of the head on its axis depends upon the stimulation of the sensitive hair cells of the neuro-epithelium of the cristæ in the ampullæ of the semicircular canals. When there is a rotatory movement of the head, the inertia of the endolymph causes a slight backward current, which passes over the hair cells in the opposite direction to the rotation. This current is greatest in the canals whose planes lie most nearly in the plane of rotation. The inertia of the endolymph of the semicircular canals is soon overcome, the current ceases, and there is no further stimulation of the cristæ. Sudden stopping of a rotatory motion causes the endolymphatic current to flow in the opposite direction and gives rise to a sensation of reversal of motion.

The central connection of the vestibular nerve explains its importance in the equilibration mechanism. It is connected chiefly with the lower centers of the brain where are found sensory and dynamic centers of equilibration and coordination, which carry out the complicated unconscious or reflex acts requisite for the maintenance of equilibration, muscular force and blood tension. The sensations of equilibration from the labyrinth are of such a nature that they are both positive and negative. This is accounted for by the balancing function of the peripheral space organs which take note of motions in all directions.

PROTECTIVE MECHANISM.

The external ear is a cushion and guard to the external auditory canal. The external canal is a protection to the parts within, since the curves of the canal render the passage of a straight object difficult. The cerumen secreted by the walls of the cartilaginous canal entangle particles of dust or small foreign bodies, or living creatures that may stray in, and holds them securely. The hairs at the entrance of the canal also serve to prevent the entrance of dust and insects, and to hinder the inflow of water. The outward growth of the horny layer of the canal carries with it any foreign

particles resting upon it, and the cerumen and foreign bodies which have become entangled in it, and deposits them outside. This movement of the epithelium tends to efface superficial scars. The growth commences in the cul-de-sac at the anterior-inferior part of the fundus of the canal and is directed upward, backward, and outward across the drum membrane.

The protective mechanism of the middle ear is the ossicular chain. With its joints and muscles it is able to lessen the shock of too violent impulses from without, and to protect the delicate labyrinthine structures from concussion and overstimulation. The delicacy of the adjustment of the acoustic balance dampens gross movements and facilitates the transmission of minor movements. It also serves to protect the drum membrane from rupture and the attachment of the foot-plate from injury. These ends are accomplished by fixing the chain at both ends through the contraction of the intratympanic muscles. The protective contraction of the muscles takes place involuntarily when the individual sees a flash of bright light, hears a loud noise, or anticipates or feels a shock, explosion or blow on the head. The contraction of the muscles draws the drum head in and renders it less liable to rupture from the expansion wave following the condensation wave of an explosion. The protective functions of the tube are the maintenance of equal air pressure on both sides of the membrane and the ejection of dangerous material from the tympanum.

Anemia of the labyrinth from internal pressure is safe-guarded by a number of outlets for the perilymph and endolymph. The labyrinth has two aqueducts and two fenestræ. The aqueducts and the internal auditory meatus connect directly with cranial lymph spaces ready to carry away any superabundant fluids. Sudden intralabyrinthine pressure is neutralized to a slight extent by the mobility of the membrana tympani secundaria of the round window and of the foot-plate of the stapes. Excess of pressure from the outside of the fenestra is warded off by the contraction of intratympanic muscles. Too low a tension in the labyrinthine fluid causes venous stasis which results in transudation of serum and restoration of the hydraulic balance. The required fluid may also be supplied by the inflow from the lymph spaces of the central nervous system through the aqueducts. The normal intralabyrinthine pressure is about the same as that of the cerebrospinal

fluid which is one-tenth to one-seventeenth that of the carotids. The balance of tension of the endo- and perilymph is maintained by the elasticity of the delicate membranous wall of the endolymphatic tube. The endolymph and perilymph are practically one fluid.

Rapid changes of the tension of the labyrinthine fluid are also guarded against by the abundance of blood-vessels in the membranous labyrinth, chiefly in the stria vascularis. Under normal conditions the mechanisms are ample to correct any accidental change in the tension of the labyrinth and to protect the delicate neuro-epithelium. Pathological changes of both the blood-vessels and lymph channels may be expected before the tension is noticeably interfered with.

The deep position of the hard, bony labyrinth serves for the protection of its extremely delicate structure.

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CHAPTER XXVII.

PHYSIO-PATHOLOGY. DISTURBANCES OF THE AUDITORY FUNCTION.
DISTURBANCES OF THE EQUILIBRATIONAL FUNCTION. MINOR
DISTURBANCES OF FUNCTION. CENTRAL NERVOUS
DISTURBANCES.

GENERAL PATHOLOGY. FLORA AND FAUNA OF THE EAR.

PHYSIO-PATHOLOGY.

The functions of the ear show deterioration when any part of the ear is affected by disease. The most important of these functional losses are, diminished power of sound-perception and defects of equilibration. The less important losses are in the normal unconscious sensations derived from the ear which take cognizance of the pulse rhythm, of respiratory rhythm and sound, of vascular, intestinal, joint, lymph, and muscular sounds, and of minor sounds from surrounding objects. Through these unconscious perceptions we are able to take cognizance of the teeth, the intestines, the hands, the feet, the clothes, etc. When the hearing and the equilibrational senses are altered, these unconscious perceptions are also altered and the misinterpretations which follow have an injurious effect on the functions of the body. The results are reflected in altered processes, such as abnormal circulation, respiration, etc.

DISTURBANCES OF THE AUDITORY FUNCTIONS.

Deafness, when not due to defect in the nervous mechanism of hearing, is due to defect in the sound-conducting apparatus by which sound is lost on its passage from the outside air through the drum membrane, ossicular chain, peri- and endolymph, and sensory hairs of the organ of Corti, to the hair cells where the transformation to nerve motion takes place. Leaving out of consideration physical obstruction to the aerial passage of sound,

and the hindrance of sound transmission in the labyrinth, we come to the consideration of the mechanism for sound conveyance in the middle ear. The efficiency of this mechanism depends upon the delicacy of the acoustic balance. The acoustic balance is destroyed by any alteration, addition, or loss of tissue which disturbs either the vibratory power of the membrane or the mobility of the ossicles. Alterations of the elasticity of the drum membrane, increased or diminished tension, similar changes in the ossicular ligaments, or the absence of physiological action of the intratympanic muscles impede sound transmission and interfere with the perception of the highest and lowest tones. Increased tissue, due to congestion, hypertrophic thickening, inflammatory swelling, or accumulation of products of inflammation also interfere with sound transmission. Loss of tissue, whether it be a tiny hole in the membrana vibrans or a loss of membrane and ossicles, will also cause an interference with sound transmission. The loss of tissue can be remedied, to some extent, by substitution of mechanical devices. A perforation in the drum-membrane may be closed by substituting for the lost vibrating surface a thin piece of sized paper or a small pledget of cotton, soaked in vaseline or water. These artificial drum membranes may also serve in case of relaxation of the membrane and ossicular ligaments, as weights and springs to hold the ossicles in apposition. In loss of all the ossicles or of the two major ossicles only, pledgets of cotton similarly prepared, will furnish resistance on the oval window, stapes, round window, and promontory which will improve the acoustic balance and greatly assist the hearing.

The presence of an occluded Eustachian tube, irrespective of tympanic ventilation, inhibits hearing. The relief after blowing out a tube filled with secretions in cases of loss of tympanic membrane is very marked.

Owing to the decussation of the cochlear nerve fibers and the operation of only one side of the brain for the auditory center, a sympathetic inhibition of the functions of the normal ear is brought about by a deaf ear.

In advancing age diminution in hearing occurs in a constantly decreasing ratio. The loss begins before the thirtieth year and continues rapidly to the sixtieth or seventieth year, and then more slowly to the end of life.

The term *aphasia* is applied to the condition resulting from a loss in the speech mechanism. Sensory aphasia is the loss of the power to hear or feel words. Aphasia in its sensory form is due to some break in the nervous mechanism of the auditory center, or its association tracts and its associated cortical centers. The symptoms, which indicate impairment of some particular part, locate the lesion in that part. Amnesia, which is one form of aphasia, is the inability to remember the proper words. Psychological deafness alone is present when sounds are not heard, but when reflex acts, such as winking, follow auditory stimuli. *Deafmutism* is applied to cases of deafness which have never perfectly developed the speech function.

Tinnitus is a common accompaniment of pathological conditions, especially of impaired acoustic balance. Tinnitus is due to stimulation arising anywhere in the auditory tract, peripheral or central. This stimulation, when peripheral, is due either to a stimulation of the sensory epithelium of the cochlea caused by the reverberation of somatic sounds which would escape unheard through a normal middle ear or to very loud somatic sounds. The stimulation of the auditory tract may come from other forms of irritation, or may be reflex in nature. Snapping and cracking are due to the outward or inward motion of a relaxed drum head from manometric tympanic changes; these sounds may also be due to the opening of the pharyngeal tubal mouth when the mucosa is sticky.

In mentally unbalanced persons the tinnitus, because of the abnormal psychological conditions, gives rise to stimulation of the auditory centers which is misinterpreted to correspond with fixed ideas or hallucinations. In this way, tinnitus is the first cause, as well as the constant accompaniment, of *auditory hallucinations* in the insane. By its mental effect, or by the physical and mental exhaustion due to sleeplessness and the despair which it causes, tinnitus is sometimes the exciting cause of insanity.

A drawing feeling in the ear is due to contraction of the tensor tympani muscle or to a negative air pressure in the tympanum. A full or heavy feeling is due to the presence of fluid in the tympanum, to over-distention of the drum-membrane, or to swelling of the tissues.

Paracusis of Willis is a frequent symptom accompanying rigidity of the middle-ear sound-transmitting mechanism. With this symptom patients often hear better in a noise than in a quiet place,

since the noise can move the rigid structures and allow the feebler voice sounds to pass in.

Autophonia is the phenomenon which occurs when the middle-ear mechanism is obstructed, and is caused by the reverberation of sound reaching the middle-ear by bone conduction. This symptom gives the strange hollow tone which the patient sometimes notes in his own voice, causing the voice to sound as if his head were in a barrel. The patient's foot-falls also sound strangely loud to him.

Diplacusia, or double hearing, is due to difference in tension between the mechanism of the two ears. *Pseudoacusis*, false hearing, or *diplacusia binauralis disharmonica*, is due to the altered quality of tones heard in the two ears, giving these tones an apparent difference in pitch. Defect of acoustic balance is responsible for this symptom, which often causes great annoyance to musicians. *Hyperacusis*—abnormally acute hearing—and *Dysacusis*—abnormally painful sensitiveness to ordinary sounds—are phenomena due to weakened functional resistance of the nerve ganglion cells and centers, and to the painful emphasis of certain tones due to disturbance of the acoustic balance. After-impression sounds, that is, continuation of the sound sensation long after the sound has actually ceased, is also due to instability of the auditory ganglion cells. After-impression sounds—so-called after-impression tinnitus—is similar in its pathological cause to after-impression visual images, and is due to overstimulation of the cochlear nerve or central mechanism.

DISTURBANCES OF THE EQUILIBRATIONAL FUNCTIONS.

Vertigo and dizziness are states of incoordination, resulting from overstimulation or unbalanced stimulation of the peripheral organ of equilibration, its central tracts, the muscular and circulatory systems, the visceral and tactile senses, and the eyes. Vertigo is a subjective sensation of motion of the body in space. The cause of the subjective sensation may be a positive or a negative stimulation of the vestibular apparatus. If the vertigo has a positive unilateral cause, the subjective motion is to the side of the affected vestibular apparatus. The patient in his attempt to correct his sense of loss of equilibrium and stem the tide of

objects which appears to move toward him from the side of the affected ear, falls on the affected side. He rarely tries to keep pace with the moving object, and consequently seldom falls on the healthy side. If the vertigo has a negative unilateral cause due to paralysis of one of the peripheral organs of equilibration, the subjective motion is toward the individual from the side of the healthy ear. The patient, by excessive attempts to retain equilibrium, throws himself away from the affected ear and falls on the healthy side. If the dizziness does not cause the patient sensations of falling in any particular direction, it is due to an irritation of the whole vestibular organ.

Nausea, vomiting, cold sweats, sea-green complexion, slow and weak pulse, and great muscular weakness, associated with vertigo, are consequent on the stimulation of the vagus nerve, through its close connection with the vestibular nerve.

Nystagmus is due to overstimulation or unbalanced stimulation of the semicircular canals and vestibular apparatus, or of their tracts or centers in the brain, or to an irritation of the ocular part of the rotational equilibration mechanism. It is due to the subjective sensation of rotation, and is in the plane of and direction of this rotation. The rapid motion of the eyes when the nystagmus is due to irritation of otic origin, is toward the side of the affected ear; that is, in the direction opposite to the subjective motion of surrounding objects. With paresis or paralysis of one vestibular nerve, nystagmus, when present, is toward the healthy side; that is, in the opposite direction of the subjective motion of the surrounding objects.

Seasickness is due to overstimulation of the vestibular nerve and occurs when the centripetal action of the otoliths is too powerful and when the change in the stimuli is repeated too frequently. The consequent exhaustion which results causes loss of equilibration and coordination and an associated stimulation of the pneumogastric nerve, with the consequent sensory, muscular, visceral, and circulatory phenomena. Individuals without a vestibular apparatus are not affected in this way. The immunity from the phenomenon of seasickness when the patient is flat on the back is due not so much to the elimination of the muscular, visceral, and ocular vertiginous symptoms as to the location of the maculæ acusticæ or sensitive areas of the vestibule, which lie on the anterior wall of

the vestibule; therefore in this position the otoliths do not irritate the sensitive nerve epithelium, and no excessive stimulation results. The phenomena of seasickness resemble the sensations caused by a rotatory swing, except that in the sensations from the rotatory swing, the cristæ acusticæ receive the chief stimulation, whereas in seasickness the maculæ acusticæ are chiefly stimulated. In seasickness the motion is less violent, and a longer time is required to accomplish the reaction.

MINOR DISTURBANCES.

Pain or otalgia is due to inflammatory pressure on the sensory nerves of the ear, and is accompanied by local signs of inflammation. *Reflex pain* may originate in the ear and be referred to other organs, or it may originate elsewhere and be referred to the ear. The fifth, ninth, and tenth nerves are the ones usually implicated. The dental, pharyngeal, laryngeal, and nasal reflexes are the most common. When there is no congestion of the middle ear, the otalgia is always reflex. The reflexes are more often aurotropic than aurofugal.

Itching is due to local irritation, congestion, dryness of the skin of the meatus, tickling of hairs in the meatus, to particles of cerumen, desquamated epithelium, or small foreign bodies. Internal itching may be due to mild irritation of the mucous membrane of the middle ear tract, especially at the mouth of this tube. Reflex itching, referred to the ear, originates usually in the nasopharynx. When the itching sensations originate in the ear, they are often referred to the nasopharynx or larynx, causing sneezing and coughing.

CENTRAL NERVOUS DISTURBANCES.

Epilepsy is sometimes dependent on aural diseases, epileptic seizures often following aural irritation in the predisposed.

Aprosexia is a common result from persistent ear symptoms, such as pain, tinnitus, or the indescribable discomfort of ear disease. The patient, because of the persistence of the discomfort, is rendered incapable of mental application.

Insanity.—Cortical irritation or toxemia from ear infections may go to the point of causing insanity in patients mentally unstable

and with slight resistance. The form which the insanity takes is the toxic, depressant type.

Diminished activity of the auditory tract is usually associated with arrest of mental development and loss of function, which is in proportion to the severity of the auditory symptoms. These mental disturbances are due partly to the aprosexia, consequent on the abnormal symptoms, and partly to the absence of concepts dependent upon lack of words to express mental processes.

GENERAL PATHOLOGY.

The general pathology of the ear has nothing peculiar to itself. The changes in the tissue, taken as a whole, are of the same character etiologically and pathologically as the changes in similar tissue in other parts of the body.

The systemic diseases which often have ear complications are: influenza, measles, scarlet fever, pneumonia, epidemic cerebrospinal meningitis, syphilis, diphtheria, tuberculosis, typhoid fever, diabetes, pernicious anemia, and leukemia.

FLORA AND FAUNA OF THE EAR.

Parasitic Flora.—A very large variety of bacteria are parasitic in the ear and are the cause of aural inflammation. A still larger number are occasionally parasitic under conditions of preexisting inflammation. There are also a certain number of parasitic moulds and aspergilli. Certain of the well-known pathogenic bacteria have a special predilection for the ear, where they show well-marked biological and pathological characteristics which influence clinical procedures and affect the prognosis of the otitis. Aural discharges usually contain two or three varieties of pathogenic bacteria and various saprophytic bacteria.

The entrance of bacteria is favored by lowered vitality, by rickets, anemia, diabetes, nose and throat affections, inflammation of the external auditory canal, and wounds of the skin.

Streptococcus encapsulatus is the most virulent and the most fatal of the pyogenic micro-organisms. It has an almost irresistible power of extension, which involves the vital structures in the neighborhood of the middle ear. A biological and pathological characteristic

of great importance is that its progress is often almost painless. While the infection spreads and the bone becomes completely disintegrated, the progress of the infection may cause only a minimum discharge of pus, a slight inflammatory reaction or swelling, and little or no change in temperature.

Streptococcus pyogenes, the most common cause of ear infection, and the most virulent next to the *streptococcus encapsulatus*, is often present in gangrenous conditions and is a poor pus producer. Streptococci are characterized by unchecked advances in spite of surgical interference.

In cases of streptococcus infection, the inflammation extends far in advance of the bacteria, and may cause necrosis and gangrene through coagulation necrosis, produced by the toxins, before pus is found. The necrosis may extend far ahead of the streptococci themselves.

Streptococci predominate in severe cases of ear diseases and, although the most virulent of the micro-organisms, they soon lose their virulency. Complications of middle-ear infection show the same flora as the ear infections. It is noteworthy that the streptococcus is the commonest infection in complicated otitis. Sixty-six per cent. of the ear cases complicated with mastoiditis, meningitis, sinus thrombosis, perisinus abscess, epidural abscess, and brain abscess are due to streptococci.

Streptococci are especially prevalent in sinus thrombosis, and in cases with general septicemia of aural origin in suspected sinus thrombosis, blood cultures should be made to aid the differential diagnosis, since streptococcemia is a pathognomonic symptom of thrombosis. The acute process runs a longer course with streptococci than with pneumococci, but, unlike the pneumococci, the streptococci do not remain latent after the acute stage before commencing complications.

A very large proportion of infantile ear infections and their complications are due wholly or in part to pneumococci. Pneumococci are rarely found in chronic middle-ear infections.

Staphylococci occur in three forms—*aureus*, *citreus*, and *albus*. Staphylococci are the usual cause of otitis externa, and are commonly found in the canal. *Staphylococcus albus* is third in point of frequency and in degree of virulence in ear infection. It rarely occurs in pure cultures. Staphylococci are always found in otitis

media purulenta chronica. They are the most frequent cause of secondary infections consequent on otitis, and are, therefore, responsible for chronicity in ear suppuration. They occur in 33 per cent. of the complications of ear suppuration, including mastoiditis, meningitis, sinus thrombosis, epidural abscess, perisinus abscess, intradural abscess, and brain abscess.

Diplococci often cause epidural abscess, and are sometimes found in brain abscess. This organism may remain inactive for from two to six months.

Other varieties of bacteria which may cause primary infection of the ear are: tubercle bacillus, diplococcus lanceolatus, pneumococcus (Friedländer), bacillus pyocyaneus (characterized by blue pus), bacillus coli communis, influenza bacillus, typhoid bacillus, streptococcus erysipelatis, bacterium lactis aerogenes, Neisser's gonococcus, bacillus mucosus ozænæ, Klebs-Loeffler bacillus, bacillus pestis, micrococcus intracellularis meningitidis, pseudodiphtheria bacillus, anaerobic bacteria, bacillus mucosus capsulatus, and spirochæta pallida.

Otitis begins with only one bacterial excitant. A pure culture is less dangerous than a mixed infection. Middle-ear inflammation with mixed infection of several bacteria tends to become chronic, whereas cultures of a single variety of bacteria cause suppuration of short duration, or no suppuration at all. Asepsis should be rigorously employed in cases of acute suppuration or after operation, in order to avoid further bacterial contamination.

Many middle-ear abscesses in childhood are sterile. Brain abscesses of long duration may be sterile.

Since some of the bacteria may not grow on the culture media, a smear should always be taken in difficult and complicated cases of ear disease. A culture should be grown and an inoculation should be made in all cases of suspected tuberculosis in diphtheria.

Complicating middle-ear inflammations occur in the following diseases:

Two to 4 per cent. of cases of typhoid fever develop ear infections, usually in the fourth or fifth week. They are intercurrent affections, independent of the typhoid bacillus, and are caused by staphylococci, diplococci, or streptococci. Bacillus coli communis and typhoid bacillus have been found in mixed infection.

With cerebrospinal meningitis, ear disease is sometimes secondary

to the brain disease. *Micrococcus intracellularis meningitidis* proceeds along the auditory nerve from the brain membrane or through the aquæductus cochleæ et vestibuli to the inner ear. The middle-ear inflammation with the meningitis is usually a part of the general inflammation of the upper air tract and sinuses of the head.

Two varieties of ear infection occur with influenza: 1. Specific or early form, due to the influenza bacillus which gains entrance through the Eustachian tube and occasionally through the blood, and is found in the secretions of the middle ear. The ear infection begins on the first or second day of the influenza, and is characterized by hemorrhagic inflammation and the persistence of great pain in the ear in spite of drainage. 2. A secondary infection from the throat, with the usual bacteria of ear infection—diplococci, staphylococci, and streptococci.

Streptococci are the most common finding in measles otitis. The otitic infection is usually due to the inflamed condition of the mucous membrane of the middle ear and to its diminished bacterial resistance. In about 60 per cent. of the cases of measles the middle ear is affected. The infection develops about the second week.

Diphtheria otitis is caused by the Klebs-Loeffler bacillus. Primary acute otitis media is rare. A secondary middle-ear infection which accompanies the diphtheria is the most common form. The ear infection may yield a pure culture at first, but the infection soon becomes mixed. Diphtheria otitis of scarlet fever is a secondary infection on the preexisting scarlet fever otitis.

Scarlet fever otitis is of two forms—the early destructive form and the later milder form. In severe scarlatinal infections, streptococci are found in the blood, either free or enclosed in the leukocytes. These micro-organisms are also in the stroma of the mucous membrane, and sometimes in the lymph cells of the connective tissues. Both these organisms and their toxins cause ear suppuration and rapid destruction of the soft tissues and bone. In these cases, the streptococcic otitis is a symptom of general streptococcic infection. Pseudodiphtheria bacilli are sometimes the cause of ear inflammation.

Tuberculous otitis is very often the first sign of a commencing lung tuberculosis. The ear may be infected in the course of a general tuberculosis or may be the primary seat of the infection.

Syphilitic otitis is occasionally consequent on a primary lesion

of the outer parts or it may be a secondary or tertiary manifestation of the general disease.

In cases of severe aural infection serum treatment has been tried with a few of the common organisms, notably with streptococci. The results thus far have been unsatisfactory, because the cases tried were extremely urgent and could not brook the delay necessary for the preparation of the individual serum. The sera kept in stock are usually inefficient in an individual case.

Aspergilli.—The aspergilli are found in the external canal. They are only accidentally parasitic. Their growth may be



FIG. 206.—Characteristic Appearance of *Aspergilli*, showing Spores and Fibers (magnified).

saprophytic for some time before they penetrate the epithelium of the canal and become parasitic. After they have started their pathic course, they may go deeply and even penetrate, by ulceration, into the drum, where they may open the way for the entrance of more virulent organisms. Varieties of the aspergillus are the black, yellow, and white forms.

The saprophytic flora of the ear comprises a very large variety of non-pathogenic bacteria, the most important of which are putrefactive bacteria. The smegma bacillus is sometimes found in the ear, and may be mistaken for the tubercle bacillus. There is also a large variety of moulds of little importance found in the external meatus. The moulds are seen growing on collections of cerumen or inspissated discharge and epithelium. Blastomycetes and actinomycoses are sometimes found in the ear.

FAUNA OF THE EAR.

The fauna of the ear comprises visitants from among the various species of insects whose habitat is identical with that of man. These insects have sufficient strength to pass the hair barrier and are not too large to enter the canal. The forms most commonly found are: diptera, hymenoptera, lepidoptera, coleoptera, and pediculi. The only true animal parasites of the ear are diptera larvæ (maggots). They are the larvæ of the common carnivorous and house fly, which thrive in the environment of a suppurating ear.

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CHAPTER XXVIII.

ETIOLOGY OF EAR AFFECTIONS. ETIOLOGY OF PRIMARY EAR DISEASES.

ETIOLOGY OF SECONDARY AFFECTIONS OF THE EAR: 1. FROM
PATHOLOGICAL CONDITIONS OF CONTIGUOUS STRUCTURES;

2. FROM SYSTEMIC CAUSES. DRUGS THAT MAY
CAUSE EAR DISEASES. HEREDITY AND AGE.

PREVENTION OF EAR DISEASE.

ETIOLOGY OF EAR AFFECTIONS.

Etiology of Primary Ear Diseases.—The number of ear diseases with causes originating in the ear itself is comparatively small. The great majority of cases which at first appear to be primary are, when carefully studied, clearly seen to be secondary to some constitutional disease or to the effect of changes in structures contiguous to the ear, especially in the nasopharynx. In the category of primary ear diseases we have: 1. local interference with physiological functions; 2. neoplasms; 3. local and idiopathic infections; 4. trophic disturbances; 5. local injuries; 6. diseases caused by foreign bodies, and 7. diseases caused by certain occupations.

Primary ear disease may be dependent upon abnormally crooked or narrow external auditory canals, which interfere with the evacuations of normal secretions, detritus, etc. This condition of the canals favors the occurrence of eczema, accumulations of cerumen, and keratosis. The slightest occlusion of the canal may cause important middle- and inner-ear complications.

Neoplasms, when they have their origin in the ear structures, are etiological factors in the production of primary ear disease. Otic tumors include epitheliomata, carcinomata, sarcomata, endotheliomata, granulomata, myxomata, fibromata, keloid, sebaceous cysts, cholesteatomata, gummata, adenomata, papillomata, angiomas, chondromata, lipomata, aneurysms, neuromata, and branchial cystomata. These growths may be due to retention of secretion, to irritation, or to traumatism. Tumors due to retention

are cholesteatomata, sebaceous cystomata, and branchial cystomata. Tumors due to irritation, are myxomata, granulomata, fibromata, osteomata, and epitheliomata, the irritant usually being an acrid discharge from the ear. New growths due to traumatism are fibromata, keloids, and hematomata.

Idiopathic infections, as etiological factors of primary ear disease, are rare, since most primary infections of the ear are dependent on traumatism. The external ear is most subject to primary infection, erysipelas, tuberculosis, syphilis, eczema, and other skin affections. The middle ear may sometimes contain pyogenic bacteria, which may invade the tissues at times of lowered constitutional resistance.

Trophic disturbances may affect the cerumen and epithelium of the auditory canal, causing disease of the external ear. The same causes may affect the Eustachian tube and impede its functions, thus affecting the middle and inner ear. Trophic disturbances may also affect the middle ear and later involve the labyrinth.

EAR DISEASES CAUSED BY LOCAL INJURIES.

Wounds—punctured, incised, contused—and bites cause ear disease, through infection and resulting deformities.

All accidents, with loss of continuity, besides the immediate harm and injury to the hearing mechanism, may open the way for infection.

Boring the ears for earrings often causes keloid, especially among the African race. *Falls* may cause fracture of the temporal bone, associated with fracture of the base of the skull, and consequent injury to the ear. Falls, blows on the ears, explosions and very loud sounds may cause rupture of the drum membrane and injury to the organ of Corti, either from the compression or expansion wave which follows. In the case of explosions, the rupture is generally caused by the expansion wave, and occurs in the posterior half of the membrane; whereas with blows on the ear, the rupture is due to compression and usually occurs in the anterior half of the membrane. Accidents may befall the nervous mechanism of the cochlear nerve from the blast of small guns and small explosions, from long-continued musket-fire, from rapid-firing machine guns, impact from steam whistles, loud voices, and other intense sounds.

Extremes of cold and heat are sometimes factors in causing ear disease. Frost-bites produce inflammation of the external ear. Chilling of the middle ear may be the exciting cause of injection and inflammation. Burns and scalds are more liable to injure the exposed surface of the pinna than the inner parts of the ear, which, because of their deep position, are rarely affected.

Faulty personal hygiene of the ears, such as scratching or picking the ear with finger-nail, hatpin, hairpin, toothpick, match, pin, pencil, or towel, is a frequent cause of infection of the canal, otitis externa, and dry eczema. Snuffing instead of blowing the nose, and swallowing with obstructed nostrils, by aspiration of the air in the tympanum, are causes of diminished intratympanic pressure and consequent injury to the acoustic balance. Too forcible or too frequent inflation of the middle ear is a usual cause of relaxed tympanic membranes, a serious obstacle to hearing. Too hard blowing of the nose may cause the same relaxation. Too forcible or too frequently repeated pneumatic massage may also cause relaxation of the drum membrane and of the ossicular ligaments, with loss of acoustic balance. Too frequently repeated sound massage is sometimes the exciting cause of boiler-makers' disease and of nerve impairment.

Improper handling of the ear by its possessor or by others, including mistaken acts of ear toilet or of hydropathic and physical therapeutics, is a frequent cause of primary ear disease.

The use of fluids in the nasopharynx for therapeutic purposes, especially the use of nasal and postnasal douches, often results in the blowing, aspiration, or syringing of the fluid from the nasopharynx into the tympanum, thereby clogging the mechanism and causing infection. Snuffing fluids up the nose through aspiration or subsequent blowing drives the fluid with bacteria into the middle ear and causes infection.

Bathing is often accompanied by the clogging of the nasopharynx with water and mucus. In the effort to remove these fluids by blowing the nose or by sniffing, water or infected mucus may be drawn into the middle ear through the tympano-pharyngeal tube where they often excite infection and inflammation. Water and sand may enter the fundus of the canal during bathing and act as irritating foreign bodies and as excitants of infection. The continued presence of water in the canal is the usual cause of

osteomata and hyperostoses of this region. Deep diving, owing to compression of the tympanum, may cause considerable injury to the sound-conducting structures.

Improper violence in the removal of foreign bodies is often followed by injury to the canal and tympanum. Unskillful use of instruments in the canal and middle ear rapidly causes injury and disastrous consequences. Results are laceration and contusion of the external parts, with possible infection, rupture or puncture of the drum membrane, and sometimes dislocation of the ossicles.

Foreign bodies, which are the most frequent cause of primary ear diseases, are usually put in the ear by the patients themselves, though occasionally by others; insects may sometimes crawl into the ear. Foreign bodies give rise to disease by irritation and by obstruction of the canal and tympanum.

There are certain *occupations* which, by continually exposing the ear to an abnormal environment, are potential causes of injuries to the ear. Boiler-makers and men employed in gunneries often have ear trouble because of their noisy employment. Swimming, which exposes the ear to too much water, and diving and caisson work which expose the ear to too much or to too little pneumatic pressure, are among the occupations likely to affect the organ.

Etiology of Secondary Ear Affections Which Arise from Pathological Conditions Near the Ear.—The pathological processes of the upper air tract affect the ear directly by extension along the mucous membrane, and indirectly by extension through lymphatics and blood-vessels, or by mechanical interference with the function of the Eustachian tubes. Much injury may befall the ear through vasomotor disturbances affecting its blood supply arising in the nasopharynx. Partial or complete obstruction of the nose or pharynx and inflammation of the nasal mucosa and of the nasopharynx, coryza, tonsillitis, hay fever, etc., cause closure of the tubes and circulatory disturbances of the ear predisposing to ear infection. The nasopharynx through the influence of blocked Eustachian tubes with impeded drainage and ventilation of the drums furnishes the predisposing cause of between 80 and 90 per cent. of all ear diseases. The nasopharynx also affects the ear unfavorably through circulatory disturbances, both direct and reflex.

Skin affections of the face often affect the ear by extension; these are erysipelas, eczema, epithelioma, syphilitic erosions, and lupus.

Occasionally affections of the cerebrospinal system invade the ear by direct extension from within, especially in epidemic cerebrospinal meningitis. The auditory nerve and roots are sometimes affected by the extension of lesions from the contiguous parts of the brain, in tabes, general paresis, and multiple sclerosis. New growths may extend to the auditory nerve and roots. Pathological conditions of surrounding structures sometimes affect the ear unfavorably; among these affections are hypertrophy of the faucial and pharyngeal tonsils, parotitis, lymphadenitis, aneurysms, and new growths.

Reflex, trophic, and circulatory ear disturbances may arise from irritation of the pharynx, nose, or teeth. The circulatory changes take place first, and the trophic changes are consequent. Neuralgia or sensory reflexes are very common, especially from the teeth. Irritation of the fifth nerve from carious teeth, gingivitis, from abnormal eruption of the teeth, from ill-fitting plates, and other dental appliances, nasal irritation and irritation of the ninth and tenth nerves from disturbances of the tonsils, pharynx, and larynx, also affect the circulation of the ear reflexly, and sometimes cause reflex otalgia and inflammation. Intranasal pressure and inflammation may cause the same symptoms. Reflexes from the glossopharyngeal and pneumogastric nerve sometimes cause similar ear reflexes, originating from pharyngeal and laryngeal irritations.

The etiology of secondary ear disease from systemic causes includes the general systemic diseases, circulatory changes, blood diseases, and diseases of the nerves. General systemic diseases which have a bearing on the ear are infectious diseases, such as measles, scarlet fever, diphtheria, epidemic cerebrospinal meningitis, variola, mumps, influenza, phthisis, syphilis, typhus, typhoid fever, malaria, and lobar pneumonia. Other general diseases and conditions causative of secondary ear disease are general trophic conditions of malnutrition, cachexias, Bright's disease, diabetes, and leucocythemia.

The systemic diseases affect the ear through lowered functional activity and decreased vitality and by lessened local and general resistance to infectious processes which are a part or a complication of the original disease. The first step in the process of ear involvement is the alteration of the nasopharyngeal mucosa which renders it more liable to infection, and the infection is, therefore, more liable to spread to the ear. Hearing is diminished in febrile diseases

associated with marked nervous and muscular impairment, as well as in anemia, gouty conditions, and digestive disturbances.

General circulatory disturbances which cause ear diseases do so through local anemia, hyperemia, toxemia, bacteriemia, and diseases of the vessel walls. If these conditions are prolonged they cause degenerative ear changes. Hyperemia, if active, causes hypertrophic changes which later result in atrophy. If the hyperemia is passive, resistance of the mucous membrane to infection is diminished. Toxemia has a destructive effect, especially on the nervous tissue of the ear. Bacteriemia may cause metastatic inflammations of the ear. Diseases of the vessel walls may lead to hemorrhage in any part of the auditory tract, with very considerable injury to the organ.

Diseases of the nervous system cause ear disease through interference with the nervous system of the ear which causes trophic motor and functional changes. Nervous exhaustion affects the ear before any other sensory organ. Tabes, locomotor ataxia, general paresis, hysteria, neurasthenia, and insanity affect the ear through mental impairment and nervous exhaustion.

Drugs that may cause ear disease. The most important of these drugs is quinine, which causes degeneration of the peripheral cochlear nerve mechanisms. The salicylates, the next commonest of the drugs which cause ear disease produce changes similar to the effects of quinine. Iodides, and less frequently, aconite, sometimes cause ear diseases by inducing inflammation of the pharyngeal and tympanic mucous membrane. Other drugs that have a deleterious effect on the ears through nervous disturbances of the auditory tract, centers, and peripheral mechanisms, are salol, morphine, chloroform, alcohol, and tobacco.

Heredity plays an important rôle in some forms of ear diseases, chiefly in the suppurative inflammations of childhood, and in the non-suppurative inflammations of later life. These pathological conditions are in no sense congenital, but the conditions and tendencies which give rise to them are inheritances, namely, the predisposition to adenoids in childhood and the constitutional nervous impairments of later life which affect the ear unfavorably. Ear malformations are congenital and often show an hereditary tendency—appearing and reappearing in succeeding generations. With advancing age, hearing decreases in a normally constantly increasing ratio.

The prevention of ear disease requires the successful management of the etiological factors. The majority of the causes of ear disease can be controlled by the physician, especially the most common cause, which is deranged function of the tympano-pharyngeal tubes due to disturbances in the nasopharynx.

The preservation of hearing depends upon the maintenance of the ear in its normal condition, and the prevention of further loss of hearing in damaged ears. In order that our care of the ear may be effective, it is necessary that the ear should be tested or examined from time to time—every year or so. In this way defects that have arisen may be detected and remedied before they cause any considerable damage. Care of the ear, from the patient's point of view, should be a periodic examination by the specialist; in the intervals, leave the ear intact and avoid conditions that will affect the general health unfavorably; especially important is the avoidance of nasopharyngeal disorders that reach the ear through the Eustachian tube.

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CHAPTER XXIX.

EXAMINATION OF PATIENTS. DIAGNOSIS OF EAR DISEASES.

A careful record of the examination of each patient should be kept in order to furnish a reliable basis upon which to estimate changes in the condition of the patient, and as a means of determining whether to continue or to alter the treatment.

History.—The personal history of the patient should be taken, and the data should include, besides the history of the present ear attack, the history of all previous attacks. The history should also include a record of all conditions which may have a bearing upon the present state of the ear, systemic diseases, cutaneous diseases, nervous conditions, nasopharyngeal conditions, social conditions, personal hygiene, worry, drug and moral habits, and so forth. The family history for hereditary deafness and for constitutional conditions should be recorded.

Inspection of Auricle.—The skin of the auricle and surrounding region should be inspected, and both sides compared. The presence of any superficial lesions, tumors, or deformities can readily be seen. The auricle and skin should be palpated to locate tenderness, and traction should be made on the auricle for the same purpose. Tenderness which is most marked when the tragus is pressed, indicates otitis externa. The presence of swelling adjacent to the auricle should receive especially careful investigation. Anterior swelling suggests otitis externa. If the tenderness is found to be increased toward the meatus and is absent at a short distance from it, otitis externa is probable.

Posterior swelling suggests mastoiditis. If the tenderness is behind the ear and is increased by deep pressure on the bone, rather than on the cartilage of the meatus, the indications are that periostitis exists, probably accompanying mastoiditis. Points where deep or superficial pressure locate tenderness should be noted. In cases where the differential diagnosis between otitis externa and mastoiditis is difficult, great care must be exercised when the pressure is made on the bone, in order to avoid any pressure or reaction on

the canal. There are three points of tenderness behind the ear to be considered: tenderness of the tip of the mastoid process, tenderness of the mastoid antrum—that is, directly back of the meatus—and tenderness at the posterior end of the digastric fossa and emissary veins—that is, behind the base of the mastoid process. These signs of tenderness are given in the order of frequency and in the inverse order of their importance.

Inspection of the cartilaginous portion of the canal is made to detect superficial lesions, presence of discharge, foreign bodies, tumors, or deformities. The general character of the caliber of the canal should be noted. Any considerable swelling or the presence of any

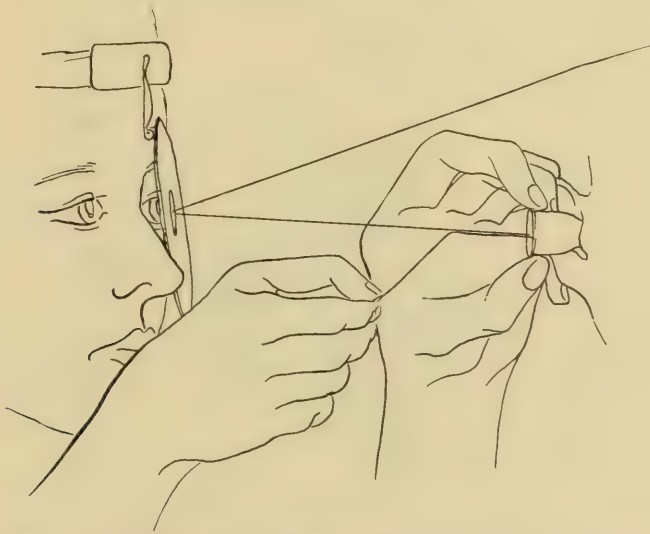


FIG. 207.—Diagram showing the forehead mirror worn on the observer's left eye, the direction and angle of the light, and the line of vision. The method of holding the fine angle applicator while fixing the depth of the ear.

foreign substance is readily observed. The character of the discharge should be noted. Circumscribed otitis externa is shown by the presence of furuncles or by localized swelling and tenderness in the cartilaginous meatus. Pressure with a probe will indicate the location of the boil by the sharp tenderness.

Examination of the osseous part of the canal requires the use of a forehead mirror, reflected light, and an aural speculum. The mirror should be worn as seen in the diagram (Fig. 207), over the left eye, on right-handed persons; the left eye should be used for looking through the aperture of the mirror for the subsequent examination. The light should be sufficiently strong to cause a distinct shadow. The position of the light, relative to the mirror

and to the ear, is important. The ear to be examined should be toward the observer, and the light beyond the patient. The light should be placed in such a position that it will come to the mirror as nearly parallel to the light going from the mirror to the ear as possible. The light should shine on the mirror just over the patient's head, to the left of the observer. The observer should tilt the mirror so that the full strength of the reflected light falls on the meatus. He should then adjust the angle of the mirror without moving his head or allowing the light to leave the meatus, so that he can see the meatus with his left eye through the opening in the

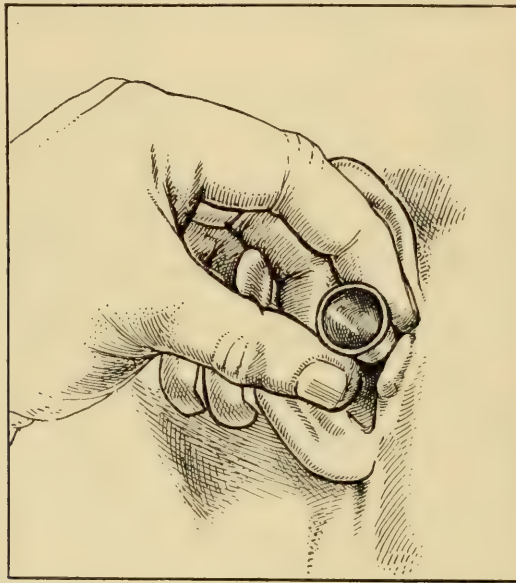


FIG. 208.—Inserting speculum in right ear. The speculum is held between the index-finger and thumb of the observer's left hand and rolled into the canal, while the pinna is grasped between the middle and ring-fingers and pulled upward and backward.

mirror. The fine structure of the tympanum cannot be seen at long range, therefore the eye of the observer should be as near the ear as working room will allow. If the hypermetropia of the operator will not allow this, he should wear in the aperture of the mirror a lens of sufficient convexity to allow him to see at close range.

The speculum should be held between the thumb and index-finger of the left hand, and inserted with caution, rolling it between the finger and thumb to avoid pain and injury to the patient. While inserting the speculum the right ear of the patient is grasped between the middle and the ring-fingers of the observer's left hand, and pulled upward and backward at the same time that the speculum is inserted with the forefinger and thumb. In the case of infants

the auricle is pulled downward. When examining the left ear, the speculum is inserted in the same way, but the auricle is pushed upward and backward by the pressure of the tip of the middle finger inserted in the upper part of the concha. The observer should insert the largest speculum which the size of the cartilaginous meatus will allow. It is less likely to cause discomfort to the patient and will afford a larger field of observation for the observer.

Since the examination must be done with one eye alone, the appreciation of perspective is difficult. In order to get the proper perspective, it is well, when an object is in view, to move the eye



FIG. 209.—Inserting speculum in the left ear. The speculum is held between the thumb and forefinger of the left hand of the observer and rolled into the cavity, while the tip of the middle finger forces the concha up and back.

very slightly. This will afford a different angle of vision, and will show differences of distance that exist between objects on the line of vision.

The osseous meatus is examined for discharge, congestion, crusts, cerumen, epithelial masses, exostoses, polypi, and other growths, fistulæ, narrowing and swelling of the walls, and foreign bodies. Swelling of the walls indicates periostitis. When located at the inner end of the upper posterior part of the canal, the swelling is an indication of osteitis of the anterior mastoid wall and is, therefore, a sign of mastoiditis. The character of the discharge is an important indication of the changes in the middle ear. Very acute inflammations are characterized by serum and blood; chronic

inflammation, by pus. The odor of the discharge indicates the presence or absence of decomposition, necrosis, and of various infections. Mucus in the discharge indicates perforation into the middle ear.

Examination of the drum membrane must be done systematically so that no detail may be overlooked. In order to be sure that the entire membrane is inspected, follow with the eye the posterior wall of the canal inward and across the drum membrane forward, observing the umbo and the light reflex, and continue forward to the anterior canal wall. Then follow the upper canal wall inward to the drum membrane. Observe Shrapnell's membrane, the short process of the hammer, the posterior fold of the membrane, and the posterior superior quadrant of the membrane. Looking downward along the hammer handle, observe the angle at which it hangs, then to the umbo, and finally downward to the inferior wall of the canal.

Drum Membrane.—The mental picture of the normal drum membrane should be taken as the basis of comparison. Any deviations from the normal are to be noted. These deviations may be classified under *color, texture, position, surface, and continuity*.

The *color* of the normal drum membrane is a pale pearly-gray. Various color changes, to pink, scarlet, dark-red, are noted in different congested conditions. Inflammatory changes are shown by a pinkish flush, darkened, in advanced conditions, into deep red. The congestion first shows itself by red lines along the hammer handle, and along the periphery of the membrane and meatal wall. The color of the promontory may be seen through a normal or thin membrane, appearing slightly yellow close behind the umbo. If the promontory is congested, the yellow color changes to a faint pink or bluish-red tint. Posterior to the promontory a darker area indicates the round pelvis. A lighter-colored line close to, and parallel to, the upper half of the handle, indicates the long process of the incus, with the stapes at its tip, resting in the oval pelvis. The tympanic membrane sometimes appears to have a bluish tinge, which is indicative of blood in the tympanic cavity. A yellowish tinge is often imparted to the membrane by the presence of pus in the tympanic cavity. White areas in the drum membrane indicate calcification. A waxy appearance signifies the absence of air in the tympanum and is often associated with the presence of fluid.

Texture.—The normal drum membrane is a thin, fibrous membrane, which, because of its fibrillated structure, is slightly opaque.

- The membrane may be abnormally thin and translucent or abnormally thick and opaque. The abnormally translucent conditions indicate a deficiency of the connective tissue fibers and an atrophic condition. The thick, opaque conditions may be due to calcification, edema, cellular infiltration, and inflammation.

The normal *position* of the membrane is indicated by the position of the hammer handle, the short process, posterior fold and light reflex. The short process of the normal membrane appears as a slight protuberance at the upper end of the hammer handle. In a normal membrane, the hammer handle forms nearly a right angle with an imaginary secant which has the short process of the hammer for its central point, and runs between the spina tympani major and anterior. In a normal membrane, the posterior fold is scarcely perceptible. The light reflex is a cone of light with its apex at the umbo, and extending three-fourths of the way into the periphery.

Abnormalities of position of the membrane are depression, retraction, extension and overdistention. When the drum head is depressed or retracted, the handle of the hammer goes backward and upward, making an acute angle at the short process. In this position the handle is perspective foreshortened. Retraction of the membrane is also shown by elevation of the umbo and by the lengthening of the light reflex. In the depressed membrane the short process of the hammer becomes abnormally prominent, and may develop a supernumerary light reflex. The posterior fold of the membrane, which normally is not conspicuous, appears as a distinct ridge, extending backward and downward from the short process of the hammer, and may develop a supernumerary light reflex on its edge.

With distention or extension of the membrane the handle of the hammer comes downward and forward, forms more nearly a right angle at the short process than in a normal membrane, and is proportionately lengthened in perspective. In overdistention, supernumerary reflexes may appear in various parts of the membrane, usually in the upper posterior quadrant near the margin, which is the weakest part of the membrane and is more apt to give way. The short process no longer protrudes, the posterior fold is entirely obliterated, and the light reflex is lost.

The outer *surface* of the membrane is normally smooth, glistening, and concavo-convex, with an umbilicated center. Contraction of the membrane, or flattening of its surface, is indicated by the change in the light reflex, which becomes very small and finally disappears altogether. Abnormality of the concavo-convex curve of the membrane is also indicated by the changes in the light reflex. There may be a break, forming two reflexes, or the reflex may be close to the umbo or at the periphery of the membrane. The light reflex always occurs on the most convex portion of the drum-

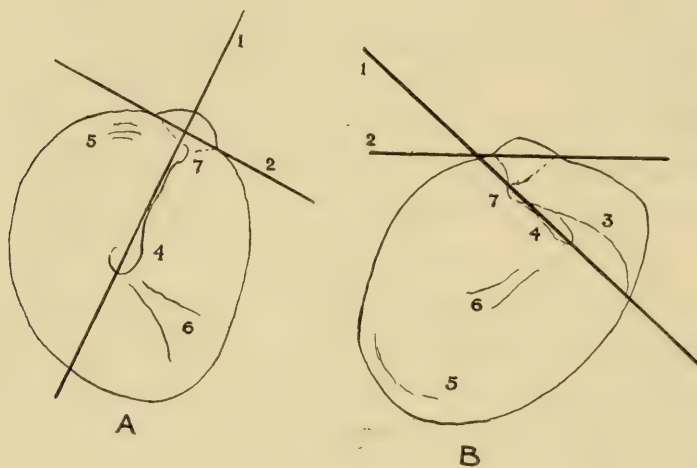


FIG. 210.

1. The axis of the hammer handle. 2. Secant across the incisura Rivini. 3. Posterior fold of the drum membrane. 4. Umbo. 5. Supernumerary light reflex. 6. Light reflex. 7. Short process of hammer.

a, A right drum membrane extended showing wide angle between 1 and 2, and supernumerary light reflex in upper posterior quadrant of drum membrane.

b, Left drum membrane retracted, showing narrow angle between 1 and 2, and supernumerary reflex at border of anterior lower quadrant of membrane, and another supernumerary light reflex on the short process of the hammer.

head. Note should be made of unevenness of the membrane surface caused either by undue prominence or depression of portions of the surface. Unevenness is usually indicated by supernumerary light reflexes on the summits of the prominences or edges of depressions. Local depressions of the surface, due to scars and adhesions, sometimes occur; the margins or sides of the depression usually show supernumerary reflexes. These depressions are sometimes turned into protuberances after tympanic inflation, making corresponding changes in the supernumerary reflexes. The surface of the drum membrane is sometimes changed from the normal which gives a bright, glistening reflex, to a powdery, dull surface,

giving a dull reflex or no reflex at all, or to a damp, shiny surface which gives a reflex from the surface of the moisture. If the inner end of the canal is wet, the light reflex is given from the side of the concave end of the canal formed by the capillary collection of fluid in the angle formed by the membrane and the walls of the canal. The surface of the membrane in severe acute cases is distorted and extremely distended, often extending nearly to the cartilaginous meatus. In less extreme cases there may be bullæ of considerable size on different parts of the membrane and adjacent canal. Naturally, under these conditions, all landmarks are obliterated. The bulging portion of the membrane is always the posterior half which, because of the oblique position of the membrane, lies between the observer and the anterior half of the membrane.

The *continuity* of the membrane is examined to determine whether there are any perforations, and, if these are found, their size, position, and the character of their margins should be carefully noted.

Examination of the Tympanum.—The tympanum should first be inspected through the meatus. The color of the inner wall of the tympanic cavity often shows through the membrane, as a pale yellow, as a pink luster, a dark reddish-blue tint, or a venous blue. The promontory is the part of the inner wall which imparts the color effect, and the color is, therefore, more marked in the posterior part of the membrane than in the anterior. The oval and round pelves and tip of the long process of the incus are usually visible through the normal drum membrane, and are very distinct through a thin drum membrane. The position of the pelves is indicated by small shadows behind the manubrium. The oval pelvis is close to the upper posterior periphery of the membrane; the round pelvis is just below the oval pelvis and behind the umbo. The long process of the incus is seen as a faint yellow line, parallel to the handle of the hammer, and close behind it. The long process appears much shorter than the handle of the hammer. If there are perforations in the drum membrane, further details of the tympanic walls and contents can be noted. The presence of discharge in the tympanum, its nature, qualities and source are to be noted. Crusts, epithelial masses, granulation tissue and polypi are to be looked for. The presence of granulations indicates long-standing irritation from suppuration, epithelial decomposition, carious bone, or foreign bodies.

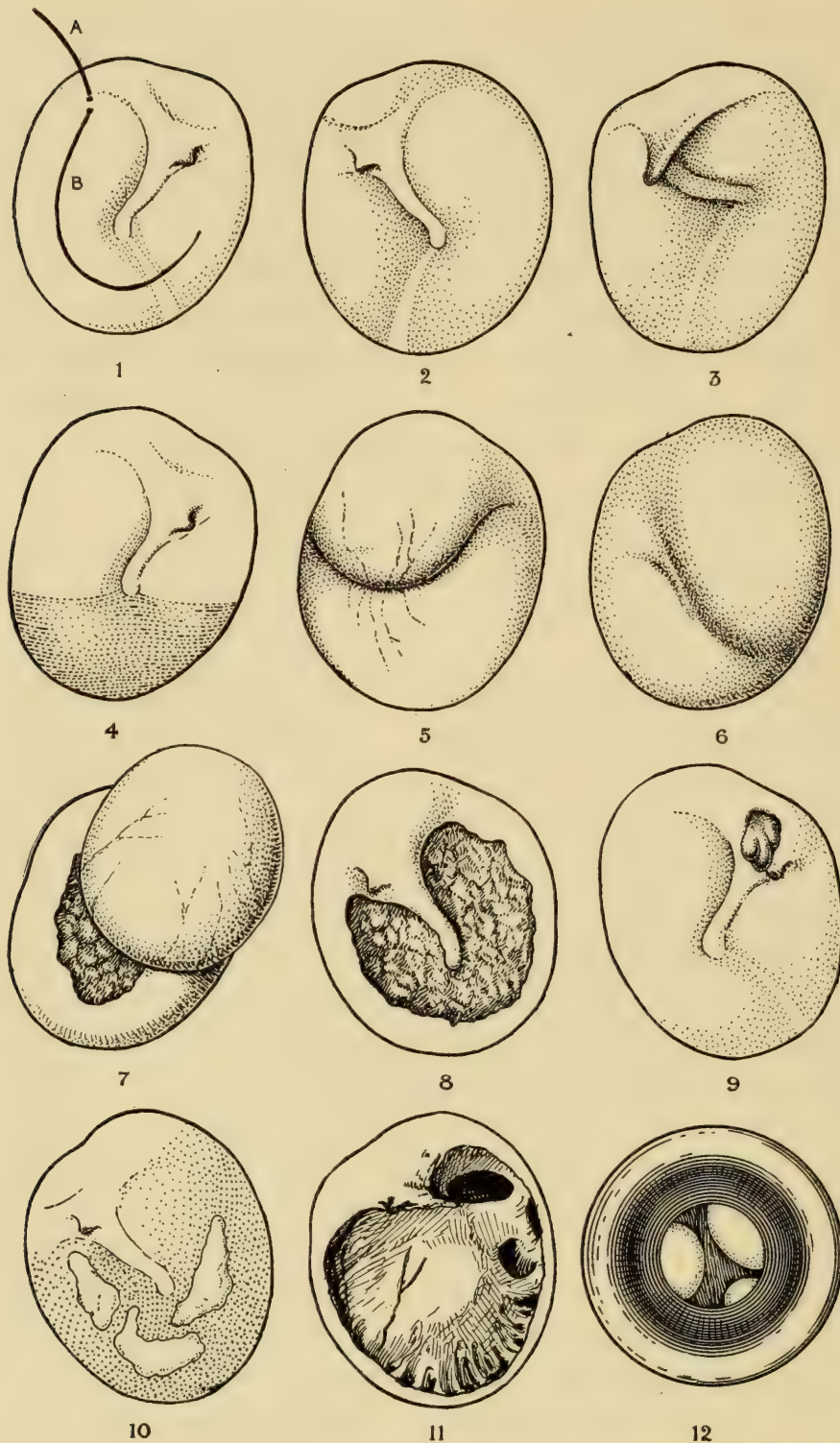


FIG. 211.

1. Normal right tympanic membrane.

a, Myringotomy. The line of incision of the upper edge of the membrane and upper posterior canal walls; *b*, the line of incision in the membrane vibrans.

2. Normal left membrane. 3. Retracted left membrane. 4. Fluid in tympanum, right membrane. 5. Right membrane, showing swelling and drooping of Shrapnell's membrane. 6. Left membrane overdistended, showing bulging of posterior half of

Examination of the Eustachian Tube.—The nasopharyngeal examination is very important, and has already been described by Doctor Knight. The patency of the tube is a vital point and must be determined by careful examination. The first test is by Valsalva's inflation. While the patient is performing this inflation, the observer should watch the drum membrane and observe any motions that follow the inflow of air, and also note the amount of pressure required to overcome the resistance of the tube. If more than slight pressure is required, it means that the tube is, at least, slightly closed. The amount of obstruction is in proportion to the difficulty of blowing air through the tube into the tympanum. By the use of the auscultation tube in Valsalva's method, the observer is enabled to determine the caliber and contents of the tube, the condition of its walls, and also the nature of the contents of the tympanum.

The character of the auscultation sounds, as indicating comparative distance, indicates the locality of the structure; *e. g.*, a constriction at the isthmus gives a much nearer sound than one midway in the cartilaginous tube. The degree of roughness of the auscultation sounds indicates the nature of the tubal surface; *e. g.*, a wet tube, or one covered with sticky mucus, gives crackling sounds of different pitch, the higher note coming with the thinner moisture. Auscultation sounds given by a fluid in the tube are crackling and bubbling râles, which are coarse for fluid containing much mucus. The sounds given by a tympanum containing fluid are not as loud, but the bubbling is more distinct.

Politzerization is used if air will not go through the Eustachian tube by Valsalva's method. The sounds in Politzerization are of the same significance, but are more distinct. The auscultation sounds indicate the size of the passage, the location of the greatest obstruction, the nature of the tubal surface, and the presence of fluid. The size of the passage is indicated by the fullness of the entering air-blast.

membrane. 7. Right membrane with large perforation, showing granulating surface of the promontory, a large polypus from epitympanum fills the upper anterior part of the field. 8. Large destruction of left membrana vibrans, exposing a granulating promontory, the handle of the hammer is exposed, characteristic of tuberculous tympanitis. 9. Right membrana with perforation of Shrapnell's membrane and protruding granulations. 10. Left membrana contracted with three areas of calcification. 11. Complete destruction of left membrane vibrans and exposure of inner wall of tympanum: Oval and round windows can be seen, stapes and incus have disappeared, a stump of the hammer remains. 12. Exostoses are seen in the canal through the speculum.

If air does not go through the tube by Politzerization the tube is physiologically closed, and the test must be made with a catheter. In catheterization, the character of the auscultation sounds is noted by the otoscopic tube as in Politzer's method of inflation. The sounds are of the same significance, but more prolonged.

Changes in Appearance of the Drum Membrane upon Inflation.—Normally, upon inflation, the drum membrane together with the umbo moves slightly outward. If inflation causes no movement of the membrane, it is abnormally rigid. If the membrane moves and the umbo remains stationary, the hammer is abnormally rigid. Laxity of the drum membrane is shown by indication of over-distention, which is usually shown by supernumerary light reflexes in the upper posterior quadrant of the membrane. A waxy membrane, when inflated, assumes a pearly color. If there is fluid in the tympanic cavity, its upper margin will probably become visible or the outlines of bubbles will be apparent. The part of the membrane above the fluid line will be pearly, while that below will retain its waxy tint. It is sometimes necessary to use a Siegel's otoscope to observe the motion of the hammer handle. By observation of the hammer handle, while condensation and rarefaction are made with the bulb of the otoscope, the degree of motion of the handle and membrane is readily noted. The normal mobility of the membrane is very slight.

Functional Tests.—Functional tests should be applied before manipulatory treatment has been employed, and repeated after the treatment to further establish the diagnosis. The tests are made to determine the power of hearing or the hearing distance and acuity, and the range of hearing or the auditory field. The voice is, functionally, the best means for distance tests, but its inaccuracy and the difficulty of providing space for its use makes the use of a watch or Politzer's acoumeter more practical. For very deaf persons, however, we can use the whispered voice, using binomials, 26, 34, 87, and so forth. The whisper is made from an empty chest, after normal expiration. If the whisper is not heard, the ordinary voice or very loud voice is tried, according to the deafness of the patient. The observer must have had much practice in order to gauge the carrying power of his voice. It is absolutely necessary that the patient should not see the observer's face during these tests. Each ear should be tested separately, the patient turning

one ear after the other toward the observer. If there is unilateral deafness, the normal ear should be hermetically closed during the tests of the other ear. This can be done by the patient inserting the moistened finger-tip firmly into the ear, or an assistant may dampen the meatus and press firmly against the tragus, thus hermetically closing the canal. In order to prove that the patient hears with the ear under examination, this ear is also stopped while the test continues. If the patient now no longer hears, it proves that in these tests he heard with the ear under examination and not with the sound ear. The patient should be made to repeat the test words which he hears. The results of the examination are expressed in a fraction. The numerator is the distance at which the sound is heard and the denominator the normal distance for hearing the sound.

The watch is a more practical distance test than the voice. The watch must always be held in the same manner by the observer, since the change in position makes great difference in the carrying power. The observer should suspend the watch by the handle between his thumb and finger, and turn the face of the watch toward the patient. The patient should thoroughly understand beforehand the part he is to play in the test, and the nature of the test. The yard-stick is a convenient measure in the examinations. When the patient's eyes have been shielded, the watch can be approached from beyond his hearing range. The distance is noted at the point when the patient first perceives the watch. Then the watch is slowly withdrawn and the distance measured when the patient loses the tick. The watch is approached to the ear for the second time until the patient again hears it, and the distance noted. The results are expressed by a fraction, for example, $\frac{15-29-23}{50}$. The 15 expresses the distance of the first observation, 29 the distance of the second observation, and 23 the distance of the third observation. The denominator, 50, represents the normal hearing distance for the individual watch. The number 15 is a relative measure of the functional powers of the auditory centers. To find the absolute measure of the power of the auditory center, find the per cent. this number 15 is of 23, the last test. This gives 65 per cent., which indicates the efficiency of the higher auditory centers. The deficiency in the auditory centers, may be either perceptive or conceptive. The number 29 is the measure of the major hearing

distance. The number 23 is the measure of the minor hearing distance. The difference between 29 and 23, that is, 6, is the measure of the accommodative defect of the ear plus the after-impression hearing, if any exists. The absolute measure of the accommodative efficiency is found by getting the per cent. which 23 is of 29.

The presence of after-impression hearing is determined by rapidly withdrawing the watch beyond the hearing distance, and noting if the patient still hears it when it is obviously beyond his true hearing distance, as shown by the previous test.

The chief use of the watch test is to give a ready means of measuring the change in hearing during the course of treatment. If the watch is not heard, the Politzer acoumeter is used with the same technic. Rapidly varying hearing distances are an indication of vasomotor instability. Diminished hearing distance indicates disease of the outer, middle, and inner ears, and of the auditory centers. Proportionately poor hearing for the voice, compared with the watch and acoumeter, indicates loss of lower tone perception, or deficient cortical perception. Proportionately poor hearing for the watch and acoumeter, compared with the voice, indicates loss of high tone perception.

The auditory field is next determined. For the tests to determine the low limit of tone perception, a tuning-fork, say C_2 , is taken and sounded close to the concha. If the patient hears a distinct note, the next lower octave is tried, until a fork is found which is not heard as a distinct musical note. Working up again by slow degrees, from the fork that was not heard, the lowest audible note is determined. The result is expressed in the rate of vibration of the lowest note heard, say 64 single vibrations. The human voice is best heard by persons who have good perception for low notes. A disproportionately large loss of low tones indicates an impairment of the sound-conducting mechanism of the middle ear and external canal. The high limit of tone perception is determined with Edelmann's Galton whistle. Beginning at a high pitch, the pitch is gradually lowered until the patient hears a definite squeak or whistle. If the upper range of hearing is below the low limit of this whistle, the upper tuning-forks are necessary to determine the upper limit of tone perception. A disproportionately large loss of high tones indicates a defect in the nervous mechanism.

The Tests for Relative and Absolute Air and Bone Conduction and for the Efficiency of the Auditory Nerve.—Take a fork of 192 single vibrations, if the patient can hear it, or a fork of a higher pitch, if necessary; the normal time that the forks can be heard must have been determined previously. The fork must then be set in vibration with a constant momentum. In order to gain a constant momentum in a fork of low pitch, the prongs should be pinched together and then allowed to snap back as they are drawn through the fingers; for forks of high pitch, the fork should be struck against the knee with a constant force. A stop watch should be used to register the time of hearing of the patient. For the air conduction test, approach the prongs of the tuning-fork close to the concha. In order to avoid neutralization of the sound by the interference of the waves from the two prongs, direct the flat of a prong toward the meatus. In all tests use the same position and the same distance. The patient is instructed to raise the right hand when the fork is heard and lower it when it is not. The observer, at an interval of a few seconds, approaches the fork to the patient's ear, and removes it again until the patient no longer raises the hand, when the fork is approached to the ear. The watch registers the length of time the fork is heard.

Test for Bone Perception.—The fork is sounded with a constant impulse, and its stem placed on the mastoid behind the meatus. The fork is alternately lifted and replaced until it is no longer heard and the length of time during which it is heard noted.

A rough method of getting an approximate test of air and bone conduction hearing is for the observer to compare the patient's hearing for the fork with his own; first testing the patient's hearing, and when the patient no longer hears the fork quickly trying his own ear with the fork. If the observer hears the fork, it means that the patient's hearing is less than the observer's. If the observer does not hear the fork, he should test his own hearing first, and when he loses the sound, apply the fork to the patient's ear to see how much longer the patient hears it than the observer. If there is doubt as to the results of the tests, they can be verified by placing the sounding fork against the median line of the head, on the apex, the glabella and the teeth. The patient should refer the sound to the side of the head that gave the longest time for bone conduction in the previous tests. These tests enable the observer to determine

the relative condition of the nerve mechanism and the conducting mechanism. With defect of the nerve mechanism, the bone conduction is shortened. With defect in the middle ear sound-conducting mechanism, the time for bone conduction is proportionately lengthened. The efficiency of the nerve mechanism is indicated by the result of the time of aerial hearing multiplied by the time of the bone conduction hearing. Normal hearing in middle life is about twice as long for air as for bone conduction. The bone conduction decreases gradually until old age, when it is usually absent.

Examination of the Vestibular Apparatus.—There are three chief tests for increased or diminished vestibular reaction:

1. The patient should be rapidly rotated on a stool from six to eight times. Normal reaction during rotation is nystagmus in the direction of the rotation. Vertigo and nystagmus in a reverse direction are apparent when the rotation is stopped. When the vestibular apparatus is destroyed or paretic, there is an absent or diminished reaction toward the affected side. With a hypersensitive vestibular apparatus, there is a spontaneous vertigo and nystagmus toward the affected ear, plus the normal reaction for the tests, which results in an increased reaction toward the affected side.

2. The ear may be syringed with water slightly colder or hotter than 98.6° F. With the colder water vertigo and nystagmus are apparent when the patient looks in the direction of the ear not syringed; with the warmer water, the nystagmus is apparent when the patient looks in the direction of the syringed ear. When the vestibular apparatus is destroyed or paretic there is an absence of reaction or a diminished reaction when the affected ear is syringed. With a hypersensitive vestibular apparatus there is an increased reaction upon syringing the ear.

3. The air in the external canal may be compressed and rarefied by a Siegel's otoscope. If there is a fistulous opening in the vestibular capsule, this compression of the air will cause vertigo and nystagmus toward the affected side, provided the vestibular apparatus is not paralyzed.

When the loss or impairment in the vestibular apparatus is recent, there is a nystagmus toward the normal side equivalent in amount to the unbalanced irritability. This nystagmus is similar in appearance under tests to the nystagmus of a hypersensitive vestibular apparatus.

Examination for Subjective Symptoms of Ear Disease.—The subjective symptoms of ear disease are very numerous and varied. The symptoms comprise every conceivable sound impression, variety of tone, pitch, and quality, every variety of pain in the ear and every discomfort in the head. These symptoms are variable and must be interpreted with a great deal of caution. They serve only as supplementary aids to the objective examination. The four classes of subjective symptoms include those referable, 1. to the cochlear apparatus, 2. to the vestibular apparatus, 3. to the middle-ear apparatus, and 4. to the nerves of general sensation which are connected with the ear.

Among the most important of these subjective symptoms are: *Subjective vertigo*, in which the symptoms relate to equilibration; with this symptom there is a feeling of dizziness not sufficiently marked to be observed on objective examination. *Tinnitus*, when the symptoms are subjective, and when the sounds noted by the patient are corporeal sounds. (See Physio-Pathology, Chapter XXVII, p. 477.) *Otalgias* are due to inflammations, swelling, the pressure of foreign bodies, and to reflex causes. *Paresthesias*, when the symptoms are abnormal feelings, not directly referable to hearing or pain. They are: itching in the ear; a drawing feeling; a full or heavy feeling; a feeling of distention; a feeling of motion, as of an object moving inside the ear; puffing or pulsating; snapping and cracking, bursting, intense, irregular thumping and pounding in the ear. *Dysthesias*: Various mental and sensory head disturbances, among them auditory hallucinations, aprosexia, and a great variety of cephalgias.

Acute inflammation of the middle-ear cavity or of surrounding bone requires the observation of the pulse and temperature. A temperature chart is kept while the process is active for comparison of the curves. A bacterial examination of the intratympanic pus should be made in infectious cases, in order to more definitely establish the prognosis, and to furnish more definite indications for treatment. The bacterial findings in the non-contaminated contents of the tympanum or mastoid cells are of considerable significance. (See Chapter XXVII.) *The differential blood count* should be made in all complicated middle-ear infections. Although the blood count usually is of comparatively small use in ear disease because of the superficial seat of the inflammation, it may be of service in

determining the existence of suppuration. If the suppuration is not located elsewhere, the presence of an inflammatory disturbance of the ear, which always gives local signs, indicates that the ear is responsible for the blood findings.

Diagnoses of ear disease, while comparatively simple in nature, are complicated and difficult in practice, because of the many different pathological changes which are often found in the same ear. The superficial conditions are seen on inspection. Discharge, swelling, or tenderness that have a deep-seated origin require further study. The conditions of the canal are seen at a glance. The drum membrane, if visible at all, can be immediately described. The condition of the Eustachian tube is determined in a few moments by simple tests. The nature of the contents of the tympanum is indicated by the appearance of the drum membrane and auscultation sounds. The absence of tympanic inflammation is indicated by the absolute pallor of the drum membrane and osseous canal. The condition of the middle ear sound conducting mechanism is determined by functional tests. A decrease of air and increase of bone conduction indicate obstructions of sound transmission. The cause of this impeded sound transmission is determined by the findings in the external meatus, drum membrane, and Eustachian tube. The cochlear nerve affections are determined by lessened distance hearing, shortened bone conduction, and loss of high tone perception. Vestibular nerve disturbances are indicated by alterations in the reaction of the equilibrational mechanism—whether of increased reaction or changed reaction. The gravity of an ear infection is determined on inspection, which shows distention of the membrana tympani, violent congestion, blebs, swelling of osseous canal, mastoid swelling, and by the constitutional reaction. The presence of mastoiditis is indicated by superficial periosteitis; periosteitis of the posterior wall of the osseous canal; pain increasing on deep pressure over the emissary vein or posterior end of the digastric groove; pain increasing on deep pressure over the mastoid antrum, in connection with other symptoms; febrile reaction and septic symptoms without sufficient cause apparent in other organs, and the indication of any inflammation present in the middle ear, or even in the history of a middle-ear inflammation within two months. The presence of meningitis is indicated by continued high temperature, headaches, and other intracranial

disturbances. Sinus thrombosis is indicated in connection with ear disease by rapid fluctuations of a high temperature and by the presence of streptococci in the blood. Brain abscess is indicated by focal symptoms, in combination with ear infection; also when there are intracranial signs of inflammation with past or present ear infection without symptoms of new growth or sinus thrombosis and meningitis.

After a careful examination of the general condition of the patient and of the ear, the pathological condition of the ear may be determined with accuracy and with little difficulty. The first indication for management of the case after the examination is the removal of the cause of disease, not omitting to make a record by which the improvement of the local pathological conditions can be gauged.

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CHAPTER XXX.

AFFECTIONS OF THE EXTERNAL EAR.

AFFECTIONS OF THE AURICLE.

MALFORMATIONS AND DEFORMITIES.

Congenital malformations of the auricle, which are liable to be hereditary, include the following: hypertrophia auris, or abnormal development of the ear; scroll ear, in which the auricle is crumpled forward; polyotia, in which there are imperfect attempts at developing additional cartilaginous nodules in the neighborhood of the ear; microtia, where the size of the auricle is much reduced; and anotia,

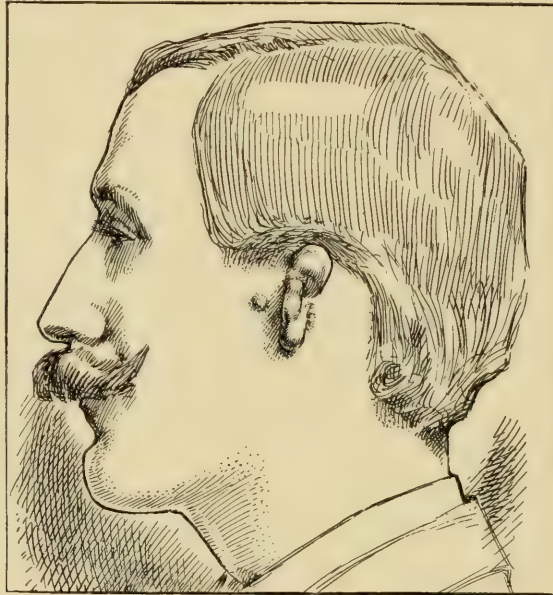


FIG. 212.—Microtia and polyotia of the left ear. The small supernumerary cartilage lies in front of the small crumpled attempt at the growth of a pinna.

where the auricle is absent. The two latter conditions are usually associated with abnormal external canals. Anotia, either congenital or accidental, is best rectified by an artificial rubber auricle. For the other malformations of the auricle, the only treatment is surgical (see chapter "Surgical Technic"). The auricle may be more prominent than is normal, or the cartilaginous folds may be irregular.

The branchial cyst or fistula, which is a rudimentary organ, is a remnant of an embryonic branchial cleft. The persistence of the cleft is of rare occurrence (see Fig. 150). These fistulæ are very narrow, tortuous capillary tubes, opening superficially in front of the auricle, and leading inward toward the middle-ear tract, with which they sometimes connect. The persistence of these fetal structures occasionally becomes surgically important, owing to the chronicity of the inflammation following infection and the possibility of malignant degeneration in later life. In these cases excision is the only treatment.

Deformities due to inflammation, such as those following chondritis or traumatic loss of tissue, are very difficult to remedy surgically on account of the difficulty of grafting cartilage.

Injuries.—The position of the auricle exposes it to wounds, and to injuries from incision, amputation, contusion, frost-bites, and burns.

Wounds.—The treatment of wounds requires special antiseptic care to prevent infection. Especially rigid antisepsis is required because of the deformities which may result from perichondritis and chondritis. The parts should be carefully cleaned and put in position. If necessary, sutures should be used to keep the parts in place. If there is not much displacement and if the parts are not infected, they should be covered with a collodion dressing. If there is question of infection having taken place, a gauze dressing should be applied and the ear bandaged to the side of the head. If the wounds show signs of inflammation, free drainage should be provided and the ear done up in a wet dressing of aluminum wash (No. 12, page 592).

Contusions of the auricle may result from slight blows and are very apt to assume a special pathological form, *i.e.*, separation of the anterior perichondrium of the cartilage, with the subsequent formation of a cyst, which may be filled with blood or serum. These blood cysts, called othematoma, while they may heal spontaneously, often become infected; in case of infection, the resulting perichondritis and loss of cartilage causes serious deformity of the auricle.

Frost-bites of the auricle are common, and, while there is no special treatment for the ear other than that which the skin of any part of the body would receive under similar conditions, the danger

from perichondritis and chondritis must be borne in mind. Embrocation of aluminum wash No. 12 should be used in the treatment of frost-bites.

Burns and scalds should receive treatment similar to that used for frost-bites.

DISEASES OF THE AURICLE.

Affections of the Skin.—The cutaneous lesions most frequently occurring on the auricle are: eczema and dermatitis parasitica from the irritation caused by pediculosis capitis; eczema and dermatitis caused by excoriating discharges of otorrhea; eczema, acute and chronic, from other causes; dermatitis phlegmonosa and gangrenosa; impetigo contagiosa and lupus vulgaris. Syphilitic skin lesions include primary lesions; tertiary lesions are not common. Treatment requires local cleanliness and constitutional antisyphilitic remedies. Cutaneous lesions of the auricle do not differ, either in etiology, diagnosis, or treatment, from similar lesions in other parts of the body; except in the cases where there is a special etiological factor, such as excoriating discharges, or pediculosis capitis, in which event the treatment must be adapted accordingly. Eczema will not yield to treatment until the cause has been removed.

Erysipelas of local origin is due to infection originating in a purulent ear, and should receive, in addition to the aural treatment, appropriate treatment for erysipelas.

Perichondritis and chondritis are very important diseases of the auricle and should receive attention as soon as any symptoms of thickening of the auricle are apparent. In the early stages of perichondritis, the auricle should be treated with a wet dressing of aluminum wash No. 12. If the process has developed to the suppurative stage, very free incisions should be made down to the cartilage in order to insure perfect drainage, and the same wet dressing continued.

Abscess of the auricle is treated by incision, wet dressing of aluminum wash No. 12, and surgical drainage.

Hyperemia of one or both auricles, if not of traumatic origin, is due to vasomotor instability, which will be relieved when the sympathetic nerve centers are in a healthy condition.

Herpes zoster is worthy of special notice, since its presence

indicates a lesion in the geniculate ganglion and facial nerve. The association of these nerves with the auditory nerve in the internal auditory meatus accounts for the presence of frequent auditory symptoms in herpes. The earache is usually extreme before the herpetic eruption appears. The diagnosis is frequently obscured by the treatment applied for the relief of the pain.

NEOPLASMS.

Neoplasms of the auricle include lipoma, fibroma, keloid, papilloma, cystoma, angioma, osteoma, carcinoma, and sarcoma. Benign tumors should be removed if they cause deformity or obstruct the canal. Early operations for malignant tumors give good prognosis. Epitheliomata yield readily to the X-ray.

AFFECTIONS OF THE EXTERNAL AUDITORY CANAL.

The affections of the cartilaginous auditory canal are in many respects similar to those of the auricle.

The *congenital malformations* of the canal are absence of the canal and atresia. Since the defect is apt to increase toward the middle ear, treatment of this latter condition is not usually effective. Any operative attempts at opening up the middle ear are apt to fail because the middle-ear structures are very rudimentary. Traumatic stricture or obliteration of the canal is easily rectified by surgical means (as described under Surgical Technic, Chapter XXXVI).

In *injuries* of the external canal, such as incisions, lacerations, contusions, and burns, the possibility of resulting atresia should not be lost sight of. When dry treatment with antiseptic powders is not sufficient to control the discharge, douching with warm antiseptic solution should be employed. Packing is not desirable except when it is necessary to hold shreds of epidermis or periosteum in position.

The presence of *foreign bodies in the canal* is one of the most common causes of ear affections of local origin. Immediate danger is not caused so much by the objects themselves as by injudicious treatment in their removal. There are recorded cases where foreign bodies have remained in the ear for years without any untoward symptoms. Small bodies in the cartilaginous canal are easily

removed with the ring curette or forceps. If the body is near the drum membrane it may be syringed out with little inconvenience to the patient. If the bodies are large they may usually be removed with the least damage by the syringe, aided by a hook or ring curette. Foreign bodies of such a nature that they will swell, such as beans and peas, should be removed as soon as possible. If the impacted body cannot be removed by the above methods it may be morcelled away with the forceps. If, however, it is too hard to be broken up, it may have to be removed by operative means (see Surgical Technic, Chapter XXXVI).

The difficulty of removing foreign bodies is often increased by previous injudicious and unsuccessful attempts at extraction, resulting in laceration of the canal, perforations of the drum membrane, suppurative otitis media, mastoiditis, etc. Swelling and infection of the canal are annoying obstacles to the removal of the body. The presence of accumulations or foreign bodies in the ear may excite a very annoying reflex spasmodic laryngeal cough.

Occasionally the hairs growing in the meatus are abnormally abundant and long, and instead of growing outward, may grow inward and touch the drum membrane, causing great annoyance. These hairs should be cut with fine scissors and removed with forceps.

Disorders of Secretion of the External Auditory Canal.—The ceruminous secretion may be entirely absent, increased or diminished in quantity, nearly fluid, or very dense. The absence of ceruminous secretion is due to a degeneration of the secretory epithelium of the ceruminous glands. This condition is usually brought about by chronic eczema.

The obstruction of the canal with cerumen, which may cause deafness, tinnitus, and vertigo, is due to improper toilet of the canal, to hypersecretion of cerumen, to abnormally viscid or hard cerumen, to an admixture of dust, or to an abnormally narrow canal. The prophylaxis of ceruminous impaction is directed to the relief of the cause. In improper toilet of the canal through mistaken ideas of cleanliness, when the cerumen is wiped out or picked out from the canal, a small portion of cerumen is pushed back out of reach. The result is that the residual cerumen accumulates, is packed in the inner end of the canal, and presses on the drum membrane instead of falling out of the canal.

Hypersecretion of cerumen is the condition resulting when the cerumen is formed to such an extent that it clogs the external canal. Sometimes the abnormal amount of cerumen can be decreased by lessening any nasopharyngeal irritation.

The ceruminous glands sometimes secrete abnormally dry or viscid cerumen, which tends to accumulate and form a plug at the mouth of the meatus.

When an individual is continually subjected to a dusty environment, such as in the occupation of coal-heaving, the dust falling into the orifice of the canal combines with the cerumen to form a thick mass which obstructs the canal. Accumulations of dust may be prevented by wearing a little cotton in the ears while exposed to a dusty atmosphere.

The lumen of the canal is sometimes very narrow at the first fold of the cartilaginous canal, thus resulting in bringing the surfaces in apposition, in closing the orifice, and in preventing the cerumen from passing out. This condition is sometimes found in the aged after the atrophic changes have commenced. With an abnormally narrow canal, a very small amount of cerumen is enough to obstruct the canal.

Treatment.—The cerumen, if in a small mass near the mouth of the canal, may be dislodged and removed with the ring curette. Soft pieces of cerumen can be wiped away. When cerumen is impacted in the canal, it can be removed with the ring curette or foreign body hook. When the cerumen is in the inner end of the canal and is adherent to the drum membrane, syringing is the best treatment. In removing large quantities of cerumen and in removing abnormally viscid cerumen, the syringe should also be employed (see "Procedures," Chapter XXXVIII, page 602). The syringing is always the final resort in removing cerumen.

SUPERFICIAL INFLAMMATIONS OF THE CANAL.

DISORDERS OF THE EPITHELIAL EXFOLIATION OF THE CANAL.

Eczema of the canal, either acute or chronic, and keratosis, cause a rapid exfoliation of epithelium which may block the canal. These affections may be due to injudicious cleansing, mechanical irritation, the presence of parasitic fungi, infection, or vasomotor

disturbances of constitutional or nasopharyngeal origin. They are characterized by itching and exfoliation of epithelium. Chronic eczema of the canal frequently causes the destruction of the ceruminous glands. A chronic eczema may develop extensive desquamation, with a shedding of concentric epithelial casts of the canal. The exfoliated epithelium sometimes undergoes cholesterin degeneration and forms a true cholesteatoma; sometimes the epithelium becomes hardened, forming a horny plug or keratosis of the canal. As the epithelial plug is continually added to by new layers, it obstructs the canal, and causes absorption of the bony wall by pressure.

Treatment for these affections consists in the dislodgment of the epithelium and the plugs, and the use of boric acid and alcohol solutions until the inflammation of the dermoid lining has subsided. The technic for the removal of the plug requires softening of the plug with alkaline solutions, or a solution containing a small amount of salicylic acid, syringing away the loosened particles and morcellation of the core. Great care is necessary to avoid the swelling incident to manipulation of the canal, and the pain and tenderness consequent upon treatment. The removal of horny epithelial plugs is extremely difficult at times, and requires patience and care in order to avoid injury of the canal. In cases of epithelial plugs complicated by severe inflammation of the canal, the removal of the plug cannot be accomplished in one treatment, without administering an anesthetic. When the canal is dry and the itching is annoying, the best preventive of the itching is lanolin and creolin, 1 ounce to 3 mm., applied lightly to the canal walls.

DEEP INFLAMMATIONS OF THE CANAL.

The pathognomonic symptom of deep inflammation of the external canal is tenderness of the cartilage, which may be demonstrated by traction on the auricle or pressure on the tragus.

Otitis externa circumscripta, or furunculosis, is a very common cause of earache. It occurs only in the cartilaginous canal, and is a purulent infection of the glandular elements and of cellular tissue. The infection may be inoculated from without by picking with the finger, or with an ear pick, or it may come in the purulent discharge from the middle ear. This affection is very painful to the

patient, and most annoying to the physician because of its tendency to recur. The strictest possible antisepsis must be practised. The sooner the furuncles are incised, the quicker the relief. Previous to incision, the best treatment is the application of camphophenique on cotton in the canal with dry heat about the ear. For dry heat use a hot-water bag or hot salt in a doughnut-shaped bag. After incision the pain is much relieved and will not recur unless a new center of suppuration arises. A hot douching with 1-2000 bichloride solution may be used every two hours, as long as the discharge continues. When the discharge has lessened, a little antiseptic dusting powder is all that is required. The furuncular abscess sometimes increases to considerable size, passes through the cartilaginous wall, and invades the tissues in front of the auricle. If the pus burrows backward, it inflames the epimastoid tissues to such a degree that the symptoms of mastoiditis are simulated.

In *otitis externa diffusa* the canal is red and swollen, indicating an irritated condition due either to infection or to some irritant. The cause should be removed if possible and local treatment for the canal applied when the pain is annoying. The treatment should be accomplished with hot antiseptics, preferably douching with saturated aqueous boric acid solution.

The external auditory canal is sometimes subject to inflammations from virulent infection. These may show hemorrhagic bullæ at the inner end of the canal, croupous exudates, or diphtheritic membranes. Local treatment for the hemorrhagic process consists in dry treatment with insufflation of boric acid powder. In the membranous inflammations treatment consists in the use of bichloride solution—1-1000 or 1-2000—as a douche, and peroxide of hydrogen to dissolve the membrane.

Inflammation of the dermo-periosteum of the canal often accompanies other inflammations of the canal as a complication; occasionally it is due to causes from within, in which case it indicates the presence of osteitis and therefore, when occurring on the posterior and upper canal walls, is a most important symptom of mastoiditis.

Inflammations of the External Meatus due to Non-bacterial Vegetable Parasites.—These inflammations are due to aspergilli, which occur in three species—black, yellow, and white. The symptom of their presence is the discovery of the mould. There is usually itching and superficial inflammation of the external

canal, which persists in spite of ordinary treatment. Diagnosis under these conditions is positive. The diagnosis is made absolutely positive when with the use of a microscope the spores and characteristic fibers of the aspergilli are found in the detritus removed from the canal.

Treatment.—It must be borne in mind that spores of these aspergilli are very resistant, and even the dust of the room in which the patient lives may become a source of infection. The best method of destroying the spores in the ear is to syringe the ear with alcohol every day for three days; this allows time for the last spore to germinate and to be killed by the alcohol; the spore itself is not injured by any ordinary reagent or usual antiseptic.

Parasitic larvæ or maggots in the canal are easily destroyed by instillation of alcohol, or tincture of iodine.

EXOSTOSIS AND HYPEROSTOSIS OF THE CANAL.

Exostoses of the canal are of two varieties: the pedunculated type which occurs near the outer margin of the osseous canal; and the sessile, which occurs near the drum membrane. The etiology of the pedunculated form is not thoroughly understood; the etiology of the sessile form may be traced to a dermoperiostitis from local irritation usually due to the presence of moisture in the fundus of the canal. It is frequently found in individuals who get water in the ears from frequent bathing. These growths may occlude the canal, thereby giving rise to deafness, or they may cause retention of secretions which ferment and produce excoriations and suppuration of the canal, perforation of the tympanic membrane, otitis media, and mastoiditis. Treatment is directed to stopping the irritation due to the moisture. If, after the arrest of the exciting cause, the decrease in swelling is not sufficient to relieve all the symptoms the growth must be removed by surgical means.

Hyperostosis of the canal is a diffuse thickening of the bone of the canal due to chronic irritation of the dermo-periosteum. Hyperostosis results in narrowing the passage of the canal. It is often syphilitic in origin.

Neoplasms.—The neoplasms of the external auditory meatus are granuloma, fibroma (keloids), papilloma, cystoma, sebaceous cyst, angioma, carcinoma, and sarcoma. Granulomata are usually

polypoid growths of granulation tissue, rarely of tubercular or syphilitic origin. They usually originate in the middle ear, but sometimes grow from the walls of the canal. In either case, the granulation tissue is due to chronic suppuration. The polypi often protrude from the middle ear into the meatus. If these growths obstruct drainage, they should be morcelled away with biting forceps. The fibroma, papilloma, cystoma, angioma, and osteoma, if sufficiently large to obstruct the canal, require surgical removal. Since the diagnosis is seldom made until adjacent structures are involved, the malignant growths of this region rarely offer a good prognosis. The treatment is extensive removal as soon as possible.

Herpes zoster of the canal occurs on the walls of the canal and drum membrane. It is similar in cause, symptoms and treatment to herpes of the auricle.

Myringitis, or inflammation of the drum membrane, is sometimes consequent on irritation or infection of the auditory canal. One of the common causes of dermatitis of the drum membrane is the aspergillus. When the condition is due to the presence of aspergilli the moulds should be exterminated by treatment with alcohol as previously described. When the inflammation is not due to aspergilli, dry wiping and insufflation of boric acid powder is the best treatment. The inflammation may spread through the drum membrane and into the middle ear and cause otitis media acuta. It may cause perforation of the drum membrane and allow the inflammation to enter the middle ear. The inflammation may be violent enough to extend through the tympanum and cause mastoiditis.

Syphilis of the external canal shows itself in mucous patches, gummata, and dirty ulcerating surfaces. The treatment for this condition consists in the maintenance of cleanliness, antisyphilitic medication, and stimulation with a 10 per cent. solution of nitrate of silver.

Suppurative fistulæ and bone caries sometimes occur in the canal. Fistulæ are due to subperiosteal burrowing of pus from the middle ear, to mastoid inflammation which is draining through the canal wall, or to caries of the canal. The caries may be due to an extension of the mastoiditis, or to necrosis of the bony part of the canal from pressure or keratosis.

Hemorrhage from the ear, when not of traumatic origin or due to ulceration, is of the nature of vicarious menstruation. This is a rare condition, and is due to the bursting of the tympanic vessels on the drum membrane along the hammer. Ulceration of the large vessels sometimes occurs in the course of suppuration of the middle ear and may result fatally.

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CHAPTER XXXI.

DISEASES OF THE MIDDLE EAR.

Middle-ear diseases, viewed from a pathological and etiological point of view, may be classified in two main divisions: I. Otitis or inflammations, and II. Trophopathia tympanica or trophic changes. These two main divisions may be subdivided, on the same basis, into:

I. Otitis, into 1. otitis media catarrhalis nita or otitis nita; 2. otitis media acuta virulenta or otitis virulenta; 3. otitis media purulenta chronica or otitis chronica; 4. otitis media tuberculosa, and 5. otitis medialuetica.

II. Trophopathia tympanica or trophic changes, into 1. trophic changes of inflammatory origin, including *a.* fibrosis tympanica, and *b.* sclerostenosis tympanica; and 2. trophic changes of vasomotor origin, including *a.* hypertrophia tympanica or hyperemia tympanica chronica, and *b.* sclerosis tympanica or anemia tympanica chronica.

I. OTITIS.—1. *Otitis Media Catarrhalis Nita*.—This group includes diseases of the middle ear, which show a mild degree of inflammation, including congestion and edema, possibly extending as far as hypermucous secretion and serous exudation.

Etiology.—The causative factor is a mild infection entering through the tube from the pharynx, from the meatus through the drum membrane, from some irritant in the blood which is excreted through the mucous membrane, from traumatism or from the irritation of the tympanum caused by acute closure of the Eustachian tube and from reflex irritation, especially of dentition.

Pathology.—There is present a hyperemia developing into serous exudation, infiltration, mucorrhea, and stopping short of ulceration and suppuration.

Symptomatology.—*Objective Symptoms*.—A slight pinkish tinge of the tympanic membrane and promontorial wall, with or without serous exudate into the tympanic cavity; edema of the mucous membrane with or without closure of the Eustachian tube; râles

present or absent on inflation, depending on the presence of fluid and varying with the amount and consistency of the fluid in the tympanum. The drum membrane is not distended. *Subjective:* Pain may be absent or very slight, or there may be occasional sharp twinges; the tinnitus may be absent or very marked; the pitch of the tinnitus is low, and there is more or less feeling of weight and fullness in the ear. The hearing may be slightly or greatly reduced. The tone field is varyingly contracted, and is especially defective for the upper notes. Inflation usually relieves the symptoms for a time. Febrile reaction is usually slight, often absent.

Diagnosis.—The diagnosis is made on the evidence of a mild inflammation in the tympanic cavity, congestion, swelling and exudation, without hemorrhage, or suppuration.

Course.—The course is transitory or prolonged, according to the nature and continuance of the exciting cause.

Treatment.—Treatment is first directed to relieving the swelling and obstruction of the Eustachian tube, which is best accomplished by applying 1-8000 solution adrenalin in a 4 per cent. solution cocaine on cotton applicators to the mouth of the tube through the nose. For tympanic drainage and for stimulation of the circulation, inflation should be performed, preferably by the Politzer method, by the catheter if Politzerization will not inflate, or by Valsalva's method if time is pressing. When there is fluid in the tympanum, the ear to be inflated should be placed in such a position that the Eustachian tube occupies a vertical position, with its pharyngeal end downward. To put it in this position, the patient bends the head forward 45° and turns the face 45° toward the side of the affected ear. The amount of inflation and the frequency of its application, are determined by the relief obtained and by the amount of irritation caused by the inflation, the object being to cause the greatest relief without any irritation. The instillation of hot saturated boric acid aqueous solution in the ear every hour or two, according to the urgency of the case, is useful to stimulate the circulation, to promote resolution, and to alleviate pain. The exciting cause of the inflammation is removed by nasopharyngeal treatment to allay any local infection or irritation, if that alone is the cause. The constitutional advantages of a laxative, such as a compound mixture of rhubarb and soda, are shown in the relief of the congestion of the tubal mouth. Reflex causes require appropriate manage-

ment. Constitutional treatment for any systemic disease having a causative relation, should receive immediate attention. Of the systemic causes, syphilis is a common one. The use of any drugs which irritate the mucous membrane should be discontinued.

Prognosis.—The prognosis is good for speedy relief and permanent cure under appropriate treatment.

Complications and Sequelæ.—Complications are possible, owing to the fact that the inflammation may become virulent. Sequelæ, other than those due to increased virulence of the infection, are the results of long chronicity. These are trophic changes, of an inflammatory origin, and later atrophic results, gradually leading to fibrosis tympanica, and later to sclerostenosis tympanica.

2. *Otitis Media Acuta Virulenta.*—Otitis media acuta virulenta is a middle-ear inflammation, accompanied by suppuration or other signs of virulent infection.

Etiology.—The cause of this virulent infection may be bacterial invasion from the nasopharynx, or very rarely superficial infection, bacteria or toxins carried by the blood, or traumatic infection.

Pathology.—Characteristics of this inflammation are inflammation of the mucous membrane, advanced to the point of serous exudation, desquamation and separation of the epithelial layer, hemorrhage, suppuration, and ulceration. The strength of the bacterial toxins may be sufficient to cause necrosis. The invading bacteria, together with their toxins, may enter the general circulation.

Symptomatology. Objective Symptoms.—There is an active inflammation of the drum membrane and tympanum, serous, hemorrhagic, or purulent. There are two types—sthenic and asthenic. In the asthenic or cold type, the symptoms are those of suppuration without much reaction; the membrane is thickened, possibly bulging, and yellow, suggestive of pus within. In the sthenic variety, the signs of inflammation range up to the most violent forms where there are hemorrhagic bullæ of the drum membrane and canal walls. The drum membrane is much thickened in all cases, extremely thick in some, and may be greatly distended from the intratympanic pressure. Perforations of the drum membrane are the rule. These soon appear in the cases where drainage through the tube is not sufficient. The site of the perforations depends partly on the changes in the tympanum before the commencement of the inflammation, and partly on the location

of the focus of the inflammation. The perforation occurs in the thinnest part of the membrane, or in the part of the membrane nearest the focus of the inflammation. In these cases, the perforations are of diagnostic value, indicating the location of the focus. Febrile reaction is slight or marked. The appearance of suppuration or of very active inflammation in the middle ear are rise in temperature and pulse rate, swelling and congestion, and the presence of pus or hemorrhage. *Subjective Symptoms.*—Usually extreme pain in the ear and its neighborhood; tenderness over mastoid and auricle is fleeting; tinnitus not often annoying. Hearing considerably reduced. Tone field contracted at both extremes.

Diagnosis.—In a typical case the diagnosis is readily made on appearance of a violent tympanic inflammation, or an acute suppurating condition; in the less typical cases, the febrile reaction and the history are sometimes necessary to make a diagnosis because of the obscurity of the tympanic symptoms. In a patient with asthenic or cold inflammation of the middle ear, with no marked signs of inflammation, it may be difficult to determine the presence of pus in the tympanic cavity without inflation and auscultation to demonstrate the presence of fluid, which the yellow or bluish tint of the membrane would denominate as pus.

Course.—If the middle-ear tract, including the Eustachian tube, was in normal condition before the inflammation commenced, the infection will in all but rare cases run its course without rupture of the drum membrane or other complications, and with little or no damage to the tympanic membrane. A slightly obstructed Eustachian tube will predispose to perforation of the drum membrane and dangerous complications. The condition of the tympanum before the occurrence of the infection is important, since any changes that have obstructed drainage will tend to aggravate the middle-ear inflammation. Individual peculiarities of the temporal bone determine the sequelæ that occur, since, if the infection spreads, it will travel in the direction of the least resistance and invade those organs and tissues which are most susceptible to the inflammation. In this connection, the arrangement of the mastoid cells and the thickness of the mastoid cortex have an important bearing, since the pus will follow the direction of the cells and will break through where the cortex is thinnest, whether externally or internally. The influence of the previously-mentioned factors, together with

the influence of the environment and opsonic resistance of the patient determines the subsequent course of the disease and its complications.

Treatment. Constitutional Treatment.—The patient should be ordered to bed and kept there until the activity of this dangerous infection has disappeared. His bowels should be kept open with repeated small doses of magnesium sulphate, his diet should be restricted, and he should be shielded from any mental activity or excitement.

A free incision of the drum membrane should be made at once under a general anesthetic, preferably ethyl chloride. If there is pus, accompanied by pain or swelling, douche the ear with saturated aqueous solution of boric acid (at 99° to 105° F.), preferably with fountain syringe under very slight pressure. The douching should be repeated while the patient is awake, from once every hour to three times a day, according to the urgency of the case and the quantity of discharge. Dry wicks of sterile cotton should be kept in the ear, renewed before they are soaked by the discharge. For alleviating pain, dry heat (either a hot-water bag or a hot-salt bag) may be applied around the ear, in addition to hot douching. Hypnotics and anodynes are rarely necessary. If the tympanic drainage becomes obstructed, the free myringotomy should be repeated. For the benefit of tubal drainage, nasopharyngeal treatment is always indicated. To aid the meatal drainage, the diseased ear may be rested on a pillow, shaped like a doughnut, to prevent painful pressure on the ear. The position to favor tubal drainage is resting the head on the healthy ear. When the swelling has disappeared and the discharge is scanty (not due to retention), discontinue the douching and substitute dry cleansing with absorbent cotton on an applicator, followed by insufflation of enough boric acid powder to cover the perforation, and lightly plug the meatus with cotton. Tympanic inflation of the ear should be performed daily, commencing when the active symptoms have subsided and ceasing only when all signs of inflammation have disappeared.

Prognosis.—The prognosis depends upon the completeness of the drainage, upon the virulence of the invading micro-organism, and upon the resistance of the patient. If the case has continued for a long time without improvement, the prognosis is poor for recovery without complications.

Complications and Sequelæ.—There is usually some impairment

of hearing following an attack of this nature. Sometimes the hearing is much impaired through adhesive processes or loss of parts. The commonest complication is the establishment of a chronic otorrhea. The other complications include all possible varieties of complications of middle-ear infection, mastoiditis, osteomyelitis, sinus thrombosis, meningitis, brain abscess, and occasionally facial and abducens nerve paralysis. These complications usually commence with mastoiditis.

3. *Otitis Media Purulenta Chronica*.—Chronic middle-ear suppuration is the suppuration of the middle-ear tract which has progressed beyond the primary acute or active advancing stage of otitis media acuta virulenta. The discharge may continue for any length of time without interruption, or the ear may discharge at irregular intervals.

Etiology.—Chronic middle-ear suppuration is one of the sequelæ of an acute virulent inflammation of the middle ear. The chronicity of the suppuration is the result of imperfect drainage.

Pathology.—Characteristics of this chronic suppuration of the middle-ear tract are ulceration of the mucous membrane, necrosis, loss of tissue and formation of granulomata, accumulation of desquamated epithelium and pus, formation of cholesteatomata, adhesions, and cicatricial contractions.

Symptomatology.—The symptoms are entirely objective, being those dependent upon suppuration, either obvious or concealed. The concealed suppuration is detected by an intratympanic exploration, performed with middle-ear applicator, curette, and probe. The appearances are very variable, depending upon the pathological changes that have taken place, upon the character and amount of the discharge, upon the location of the focus of the inflammation, and upon the location and extent of the loss of tissue. The appearances indicate the present condition of the process and its future course. By the seat of the perforation and the nature of the inflammatory reaction, they indicate the location of the focus of infection and the grade of inflammation. The odor and consistency of the discharge are to be noted, since they give some hint to the nature of the infection and the activity of the resistance. The consistency of the discharge, by the proportionate amount of serum, pus, and mucus, indicates the inflammatory process to be in the advancing, resisting, or resolving stage. The presence or absence of tympanic contents,

and changes in the bony wall of the tympanum, should also be observed.

Diagnosis.—The presence of the suppuration, with the history of chronicity and the absence of acute symptoms, determines the diagnosis.

Course.—The course of the suppuration may be one of four: subacute, chronic, perennial, or recurring. The first two courses may cease spontaneously without treatment or they may develop into one of the latter two. When the third and fourth are established they tend to continue indefinitely without change. Relapses of the acute virulent inflammation may occur at any time, especially in subacute and chronic cases.

Treatment.—Success in the treatment of chronic middle-ear suppuration depends not so much upon scientific knowledge and the drugs employed, as upon the technical skill and judgment with which the remedies are applied. Treatment is directed to the establishment of local drainage, to the removal of pathological accumulations and growths, and to the reduction of local inflammation. The establishment of local drainage sometimes requires extensive incision of the drum membrane and cicatrices. Cholesteatoma and polypi must be removed. Large polypi should be removed with biting forceps, while smaller ones may be neglected. Cholesteatoma and inspissated pus should be wiped out with cotton pledgets when possible; if they cannot be removed dry, an intra-tympanic syringe with a saturated solution of bicarbonate of soda should be employed. After drainage has been established and the pathological products removed, the inflammation must be allayed. This is preferably done by dry swabbing, by the application of lotions or soothing antiseptic agents, such as alcohol, or by the insufflation of powders, such as boric acid. Use no stronger solutions than the tissues can stand without reaction. If access to the seat of infection is difficult, these remedies are to be used through a tympanic syringe or powder blower. The remedies commonly used are described in Chapter XXXVII.

Drainage should be established through the pharyngeal tube. In order to do this, the nasopharynx should be treated for the benefit of the tubal drainage. The state of the general health is important and should receive careful attention, in order to fortify the local and constitutional resistance of the patient. In complicated cases a

complete mastoid operation is required, sometimes only a modified radical mastoid operation, and very rarely an ordinary radical operation.

Prognosis.—In all cases the prognosis for the cessation of the suppuration and for improvement in the hearing is good. The prognosis for rapid recovery is best in the perennial and recurring types; recovery in the subacute or chronic types is much slower. Certain conditions, such as bone caries of the ossicles and tympanum, localized inflammation of the epitympanum and Prussack's space, and of the fundus of the antrum or mastoid cells, tend to render the course of treatment more prolonged.

Complications and Sequelæ.—Sequelæ are impairment in hearing, slight or considerable, and occasionally persistent tinnitus. Complications are stricture of the canal, peripheral stricture of the Eustachian tube, granulations, polypi, necrosis and loss of drum membrane and ossicles, cholesteatoma, caries and necrosis of the temporal bone, cicatricial deformities and cicatricial reproductions of the drum membrane, facial and abducens nerve paralysis, mastoiditis, meningitis, sinus thrombosis, brain abscess, labyrinthine suppuration, toxemia, and bacteriemia.

Both acute and chronic suppuration may interfere greatly with the hearing through loss of parts and swelling or thickening of tissue; and after the cessation of suppuration, by a fibrosis tympanica and sclerostenosis tympanica.

OTITIS MEDIA TUBERCULOSA.

Etiology.—Middle-ear inflammation is often an accompaniment of pulmonary tuberculosis, and may be the first symptom of the tuberculous infection.

Pathology.—It does not seem probable that the middle ear is often the seat of tubercles, but rather that the middle-ear condition is due to the edematous condition of the mucous membrane in pulmonary tuberculosis extending from the nasopharynx.

Symptomatology.—The symptoms are slowly progressing cold seromucous or seropurulent, or cold purulent inflammation of the middle ear, with slow erosion of tissues, not affected by usual treatment. Tinnitus often annoying. Tubercle bacilli are rarely found in the ear discharge.

Diagnosis.—The diagnosis is positive when there is a history of resistant, slow, progressive ulcerative process of the middle ear, with slight local reaction. The *differential diagnosis* between otitis media tuberculosa and otitis media luetica is made on the basis of the history and appearances. The tuberculous otitis media is of an asthenic type with paler surfaces, cleaner ulcerations and thinner, less fetid discharge. In the otitis media tuberculosa there is a wasting away of the tissues, whereas in the syphilitic condition there is thickening and swelling of the tissues.

Course.—The course is gradually progressive, with an unfavorable effect on the systemic condition, which in turn reacts on the aural condition.

Treatment.—General systemic antitubercular treatment is indicated. Local treatment for the ear is directed to cleanliness with an attempt to prevent maceration—syrringing should therefore never be used. Dry treatment is always indicated. The author has had the best results with pyoktanin blue and boric acid, equal parts, for a dusting powder. The nasopharynx requires local treatment to reduce the swelling of the Eustachian tubes.

Prognosis.—The prognosis is good for local improvement, the final result depending upon the general condition and upon the condition of any local bone tuberculosis.

Sequelæ and Complications.—The process may extend, causing tubercular and carious involvement of the temporal bone, with various intracranial and systemic complications.

OTITIS MEDIA LUETICA.

Symptomatology.—At first there is much swelling of the mucous membrane, with seromucous exudate; the tissues break down and suppurate, causing a rough, dirty surface and foul discharge. Typical glandular nodes are found in the neighborhood of the ear, often associated with syphilitic lesions in the nasopharynx. The inflammation may be of gummatous character of the type of mucous plaques.

Treatment.—The treatment required is antisyphilitic constitutional treatment, with local antiseptic cleansing and stimulating applications of nitrate of silver. Calomel should be used as a dusting powder. The nasopharynx also requires attention,

in order to prevent stenosis of the tube and to enforce tympanic drainage. The course of the ear lesion under the usual cleansing and antiseptic treatment is negative.

Course.—There may be a rapid breaking down of the tissues, or the progress may be slow and accompanied by foul, dirty discharge.

Prognosis.—The prognosis is bad, without treatment; with treatment, excellent for rapid recovery.

Sequelæ and Complications.—Possible partial or total loss of hearing from tympanic destruction and involvement of the labyrinth or more serious intracranial complications.

Treatment of Resultant Tympanic Deformities.—The treatment of the tympanic deformities resulting from suppurative otitis is directed to removing the defect, to loosening adhesions, and to substituting lost parts. If there is no perforation of the tympanic membrane, adhesions of the drum membrane and hammer handle to the other structures are best managed by very forcible catheterization, not sufficient to rupture or relax the membrane or to cause any accumulation of irritation. Politzer plugs are also of great assistance in restoring the drum membrane to its normal position. When the tympanic membrane is perforated, it is desirable to close the perforation as soon as possible. In most cases, a disk of thin, sized paper, moistened and applied over the perforation, is enough to stimulate cicatricial repair. If this is not enough, the edges of the perforation can be roughened by scraping with a sharp curette or touched with acetic acid. When the anvil and stapes are exposed, the hearing can be improved by applying a disk of thin paper on the head of the stapes, or an artificial drum membrane, made of a small pledget of absorbent cotton, soaked in vaseline. In the cases where the stapes has been lost, the small pledget of cotton, when properly adjusted, will improve the hearing markedly. The artificial membrane should be applied over the promontory and windows. Individual cases demand special adjustment of artificial membranes.

II. TROPHOPATHIA TYMPANICA includes what has been called chronic middle-ear catarrh and otosclerosis, and also tympanic atrophy following purulent otitis media. The treatment demanded by this branch of otology is much more difficult than the treatment of suppurative diseases of the ear, and it is more important because of the larger number of sufferers from this group of affections, and because of the amount of human energy wasted through incapacity

resulting from these diseases. Otology has acquired much disrepute through incompetent management of chronic catarrhal and sclerotic conditions.

Under the head Trophopathia Tympanica are classified the following diseases of the middle ear which have no signs of active inflammation, but which, nevertheless, are not in a stationary condition, tending rather to progressively decreasing hearing. They have in common the symptoms of impeded middle-ear sound transmission, shown by increased bone- and decreased air-conduction, contraction of the tone field, and the symptom called paracusis of Willis, which indicates rigidity of the sound-transmitting mechanism. Under Trophopathia Tympanica are two divisions: 1. Middle-ear conditions consequent on otitis media, including: *a.* fibrosis tympanica, *b.* sclerostenosis tympanica; 2. middle-ear conditions consequent on vasomotor changes: *a.* hypertrophia tympanica, or hyperæmia tympanica chronica, and *b.* sclerosis tympanica, or anæmia tympanica chronica. These four forms of middle-ear disease rarely occur separately, several of them being usually combined in the same tympanum, different parts of the tympanum undergoing different changes simultaneously.

1. *Middle-ear Conditions Consequent on Otitis Media.*—Fibrosis tympanica and sclerostenosis tympanica include the cases of middle-ear disease which are characterized by thickening of the mucous membrane, by infiltration of the submucous layer of connective tissue, and by the formation of adhesive bands connecting the tympanic contents resulting from otitis media. These conditions of the middle ear are without any active inflammation. The cases are characterized by thickening contraction, rigidity, and atrophy of the mucous membranes and submucous layer without any active inflammation, but following a previous inflammatory condition.

a. Fibrosis tympanica is of inflammatory origin and is characterized by a thickening of the mucous and submucous layers.

Etiology.—Fibrosis tympanica is caused by an antecedent inflammatory condition of any grade, which occurred in the tube and tympanic cavity, and which resulted in cellular infiltration and in a proliferation of blood-vessels.

Pathology.—Congestion, infiltration, and proliferation of the submucous layer are characteristic of this condition.

Symptomatology.—The drum membrane shows some thickening,

opacity, retraction, and contraction. The handle of the hammer may be movable or rigid. The Eustachian tube is more or less obstructed. Beyond the appearances, the symptoms are wholly subjective, and consist in impaired hearing, tinnitus, and auditory paresthesia. Hearing tests indicate middle-ear lesion by increased bone conduction. The tone field is contracted, chiefly at the lower limit. The tinnitus is of low pitch, and the paresthesia is a drawing or full feeling about the ear.

Diagnosis.—The diagnosis depends upon the thickened opaque drum membrane and occluded tube, and the absence of active inflammation. The differential diagnosis from the other forms of trophopathia tympanica is made on the history and evidence of antecedent inflammation and the presence of the above symptoms. The differential diagnosis from otitis media nita is made on the absence of exudation and swelling.

Course.—The disease may remain stationary for an indefinite period. It may tend to partial or complete recovery if the functions of the Eustachian tubes are restored, or it may gradually progress. It is self-limited. If it has not already resolved after an indefinite time, it will assume the atrophic form termed sclerostenosis tympanica.

Treatment.—The most important part of the treatment is nasopharyngeal treatment which is especially directed to the tube. Forcible inflation with Politzer's air douche or with a catheter should be continued until the membrane is restored to its normal position or until there are apparent signs of commencing relaxation. These signs are bulging of the upper posterior quadrant of the membrane on inflation and the appearance of a supernumerary light reflex. Politzer's plugs are a great help in restoring the membrane to its normal position.

Prognosis.—The prognosis is good for a cessation of the tinnitus and considerable improvement in hearing.

Sequelæ and Complications.—The sequel to be feared is the change to sclerostenosis tympanica, the atrophic form. The complication to be feared is the intercurrent of acute virulent infection.

b. *Sclerostenosis tympanica* is of inflammatory origin, and is characterized by atrophy and contraction of the increased connective tissue of the mucous and submucous layers of the antecedent fibrosis tympanica.

Etiology.—The cause of this type of middle-ear disease is the

contraction of the fibrous tissue, in an antecedent fibrosis tympanica. With atrophy following the compression of blood-vessels and diminished blood supply, there is apparently some hereditary predisposition.

Pathology.—A shrinkage, atrophy, and sclerosing of the infiltrated proliferated connective tissue of the mucous membrane and sub-mucous layer with diminished blood supply are characteristics of this condition.

Symptomatology.—A normal or slightly thinned drum membrane, sometimes with calcified areas, is found. The Eustachian tube is normal or somewhat occluded, and the malleus movable or rigid. Other symptoms are similar to those of fibrosis tympanica except that the tinnitus is of a higher pitch and more varied, the tone field more contracted in the upper limit, and the hearing distance more reduced.

Diagnosis.—Diagnosis is made on the appearance of a normal or somewhat thin drum membrane, with hearing tests indicating a diminution of middle-ear sound conduction—that is, increased bone conduction and a proportionately extensive loss of low tone perception. The differential diagnosis from the other forms of trophopathia tympanica is made on the history and evidence of an antecedent inflammatory condition, and the presence of atrophy and degeneration shown by thinning of the tympanic membrane, calcification, etc.

Course.—The disease may remain stationary for an indefinite period; it may tend to partial recovery if the functions of the Eustachian tube are restored, or it may gradually progress to almost total deafness.

Treatment.—Inflation is usually contraindicated and must be used with caution in order not to cause relaxation of the membrane. The tympanic circulation is to be stimulated by constitutional tonics and by local massage. The nasopharynx requires attention for the benefit of the Eustachian tube. Astringent stimulation of the nasopharynx has a satisfactory alterative effect on the middle-ear atrophy.

Prognosis.—Without treatment, the prognosis has been indicated under course. With treatment, the prognosis is good for improvement in hearing and for the relief of tinnitus, in inverse proportion to the loss of hearing when treatment was commenced.

Sequelæ and Complications.—The complication to be feared is possible involvement of the labyrinth, due to the extension of the atrophic condition to that organ.

2. *Trophopathia Tympanica Resulting from Vasomotor Changes.*—Hypertrophia tympanica and sclerosis tympanica are the forms of trophopathia tympanica, of vasomotor origin, and are not dependent upon previous tympanic inflammations. The tympanum may be affected by congestion or anemia, of vasomotor origin, due to constitutional, to nasopharyngeal, or other reflex causes, and to toxic disturbances of the sympathetic ganglia. These circulatory disturbances interfere with the hearing temporarily, but yield to general constitutional and nasopharyngeal treatment. If the disturbed circulation persists, it tends to develop one of these forms of trophopathia tympanica.

a. *Hypertrophia tympanica* is of vasomotor origin and is characterized by congestion, infiltration, and thickening of the mucous and submucous layers.

Etiology.—The primary factor is a vasomotor paresis which causes dilatation of the vessels and congestion. The paresis originates from deficiency or exhaustion of the sympathetic ganglion and is of toxic or sympathetic origin.

Pathology.—The congestion caused by the vasomotor paresis is followed by round-cell infiltration, proliferation of blood-vessels, and increased connective-tissue formation.

Symptomatology.—The drum membrane shows some thickening and opacity, and sometimes retraction. The hammer handle, the promontory, and the inner end of the external auditory meatus often show congestion indicated by the blue color or pink flush seen through the membrane. Besides the appearances, the symptoms are wholly subjective and consist in impaired hearing, tinnitus, and paresthesia. Hearing tests indicate middle-ear lesion by increased bone conduction. The tone field is contracted chiefly at the lower limit. The tinnitus is of low pitch, and the paresthesia is a drawing or full feeling about the ear.

Diagnosis.—The diagnosis depends upon the presence of chronic congestion and thickening of the mucosa, of the drum cavity and tube, and upon the absence of active inflammation. Differential diagnosis from trophopathia tympanica of inflammatory origin, hypertrophic and plastic, is made on the absence

of inflammatory history or evidence of antecedent inflammatory conditions.

Course.—The disease may remain stationary for an indefinite period, it may tend to partial or almost total recovery if the function of the Eustachian tube is restored and the vasomotor tone re-established, or it may gradually progress. It is self-limited. If it continues to progress, it will, after an indefinite period, become atrophic from contraction of the new fibrous tissues and shutting off of the blood-vessels, and develop into sclerosis tympanica.

Treatment.—Treatment is especially directed to restoration of the vasomotor tone by building up the general system and relieving toxic causes of sympathetic ganglia paresis, chiefly to be found in the nose and pharynx.

Prognosis.—Prognosis is good for arrest of the diseased condition, reduction of tinnitus, and for considerable improvement in hearing.

Sequelæ and Complications.—Sequelæ to be feared are the change to sclerosis tympanica, the atrophic and contracting form of trophopathia tympanica. Complications to be feared are acute virulent infections.

b. Sclerosis tympanica is of vasomotor origin and is characterized by atrophy and contraction of the connective tissue of the mucous and submucous layers, and by anemia.

Etiology.—This condition is due to vasomotor disturbances which may or may not have caused an antecedent congestive condition, hypertrophica tympanica, but which may have caused primary anemic and consequent atrophic changes. There is considerable hereditary predisposition to this affection. Frequently there is a nervous shock which acts as an exciting cause.

Pathology.—The characteristics of sclerosis tympanica are contraction, anemia, and atrophy of the tympanic mucous membrane and submucous layers.

Symptomatology.—Objective symptoms. Normal or slightly thinned drum membrane, sometimes with calcified areas; Eustachian tube normally or abnormally patulous or somewhat occluded; malleus movable or rigid. The subjective symptoms are similar to those of the previous group, with this difference that the tinnitus is of a higher pitch and more varied, the tone field is more contracted in the upper limit, and the hearing more reduced.

Diagnosis.—Diagnosis is made on the appearance of a normal,

calcified, or somewhat thinned drum membrane, with hearing tests indicating a diminution of middle-ear sound conduction. Differential diagnosis from sclerostenosis tympanica of inflammatory origin is made on the absence of history or evidence of a preexisting inflammatory condition.

Course.—The disease may remain stationary for an indefinite period, it may tend to partial recovery if the functions of the vasomotors are restored, or it may gradually progress almost to total deafness.

Treatment.—Treatment is directed to the nasopharynx, as in the previous condition. Tympanic inflation is usually contraindicated. Stimulation of the vasomotor functions is imperative. This is brought about by constitutional tonic treatment, nasopharyngeal treatment directed to antiseptics and stimulation, and hygiene with local stimulation by massage, rubefacients and electricity.

Prognosis.—Without treatment, the prognosis has been indicated under course. With treatment, the prognosis is good for improvement in hearing and tinnitus in inverse proportion to the loss of hearing when treatment was commenced.

Sequelæ and Complications.—The complication to be feared is possible involvement of the labyrinth, due to extension of the atrophic condition to that organ.

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CHAPTER XXXII.

DISEASES OF THE SOUND-PERCEIVING APPARATUS.

Anemia of the cochlea, a condition found in persons of feeble circulation, is a common cause of deficient hearing in debilitated individuals. Anemia of the cochlea sometimes accompanies mental or physical shock. Since the deafness is relieved when the circulation improves with the general condition, no special management of this condition is required. The diagnosis is made on a negative physical examination of the ear, showing normal range of tone perception, diminished distance and time perception, and loss of bone conduction. In this condition the symptoms are similar to those of presbycusis, except that tinnitus is often present.

Hyperemia of the cochlea is generally associated with hyperemia of the neighboring organs. Like anemia of the cochlea, this condition is managed by general methods directed to the relief of congestion, such as phlebotomy, purgatives, diaphoretics, and emetics in acute cases, and general hygienic measures in the chronic cases. The diagnosis is made on the physical examination of the ear, which shows some congestion of the external meatus, tympanic membrane, and promontory, but no inflammatory symptoms. Functional tests are apt to be variable. The tone field is usually contracted. Tinnitus often accompanies this condition.

Hemorrhage in the cochlea is usually associated with arterial degeneration or increased arterial tension. The cause is usually weakness of the vascular walls, but it may be trauma from a loud sound or explosion, or concussion of the ear. The symptoms are of sudden onset, ushered in either by an apopleptic attack or upon the occurrence of the trauma. Loss of hearing is usually total, or only a small amount of air conduction remains. Tinnitus is sometimes extremely loud and usually of high pitch. The tone field is very much contracted, especially at the upper limit. The treatment indicated is absolute rest of the organ. If the cause is a vascular one, the circulatory system requires the ordinary treatment under such a condition. The use of iodides in increasing

doses is indicated. The treatment should be continued for several weeks or months, according to the progress made. The prognosis is unfavorable for total recovery. The amount of recovery is in inverse proportion to the extent of the injury and to the recuperative power of the patient.

Spongification of the Labyrinth Capsule or Otosclerosis.—The etiology and pathology of this condition is the same as that when the middle-ear mechanism alone is affected by the atrophic process, except that in this condition we have hyperostosis and rarefaction of the labyrinthine capsule and involvement in the cochlea. The condition may show itself first by cochlear symptoms or by middle-ear symptoms. These cochlear symptoms are the classical signs of inner-ear deafness, contraction of the auditory field, especially at the upper limit, decreased bone conduction, decreased distance and time hearing and marked tinnitus. Diagnosis is extremely difficult unless there are also symptoms of the middle-ear affections, sclerosis or sclerostenosis tympanica, which include otosclerosis. (For treatment, see Middle-Ear Diseases.)

COCHLEITIS.

PURULENT INFLAMMATION OF THE COCHLEA.

Etiology.—Pyogenic infections, involving the cochlea from the middle ear, usually pass through the external semicircular canal and vestibule. Occasionally the infections enter through the oval or round windows or through the promontorial wall. Very rarely the infection has a central origin and passes outward through the internal auditory meatus or aqueducts into the cochlea.

Course.—The course is often progressive, with a tendency to invade neighboring structures. Consequently dangerous complications, such as meningitis, or brain abscess, may arise from extension. The process is sometimes circumscribed and self-limited. The destruction may include any part of, or the entire cochlea, which in young patients may come away as a sequestrum. Under these circumstances, products of the inflammation are discharged into the middle ear.

Symptoms.—The symptoms are of two kinds: 1. septic symptoms, which depend for their severity upon the amount of constitutional absorption of toxins, which may be slight or extreme; and 2. sensory

symptoms, either total deafness or great loss of hearing and bone conduction.

Diagnosis.—The diagnosis is made on the presence of febrile reaction and sudden loss of hearing, which is out of proportion to the middle-ear conditions present.

Treatment.—The treatment may be expectant or operative. The expectant treatment is similar to that for middle-ear suppuration; the operative treatment is described in the chapter on Operations on the Labyrinth.

Prognosis.—With an early operation the prognosis indicates partial or total loss of hearing. Without operation, the prognosis is bad for recovery, on account of the danger of intracranial extension.

Syphilitic cochleitis shows characteristic specific nerve and bone lesions.

Course.—The course is usually progressive to total deafness.

Symptoms.—The symptoms are the classical signs of progressive cochlear deafness, and tinnitus, associated with the signs of the history of luetic disease. There is loss of air conduction and a contracted auditory field.

Diagnosis.—The diagnosis is made on the symptoms of a progressive cochlear affection with corroborative symptoms of syphilis.

Treatment.—Treatment is constitutional antisyphilitic and should be pushed to the limit of the patient's physiological endurance.

Prognosis.—Without treatment there is gradual decrease of hearing; with treatment, except in very advanced cases the prognosis is good for improvement, and in early cases it is good for total recovery.

Cochleitis as a Frequent Complication of Cerebrospinal Meningitis.—This disease may attack the cochlea by extension from the middle ear, or it may extend from the meninges. The disease usually progresses to entire destruction of hearing. The symptoms are great impairment of the cochlear organ, and usually absolute deafness. The diagnosis is made on the impaired cochlear function in connection with epidemic cerebrospinal meningitis. The treatment is directed to the primary affection and also to the absorption of the products of inflammation by the use of iodides. If labyrinthine suppuration is present, treatment is directed to this condition.

Cochleitis as a complication of influenza is indicated by loss of cochlear hearing in connection with or following the influenzal

infection. The inflammation of the cochlea does not often develop into suppuration, but complete restoration of hearing is not to be expected. The treatment in the acute stage is the same as that required by the general infection. In the subacute and chronic conditions, general constitutional treatment and the administration of iodides is indicated. If suppuration occurs, surgical intervention is required.

Cochleitis is a well-recognized complication of parotitis or mumps. No special treatment is known for this complication other than that given in a case of resolving cochleitis, *i.e.*, total functional rest, constitutional hygiene, and the use of iodides. It is as important to protect an inflamed auditory organ from severe stimulation by noise as it is to protect an inflamed eye from light. The prognosis is bad for total recovery. There is, however, generally marked improvement in the hearing.

Affections of the Cochlear Nerve Fibers.—Such affections are indicated by diminished hearing, decreased or absent bone conduction, loss of high notes and slow auditory reaction, giving symptoms of paresis or paralysis of the auditory nerve. The pathological conditions are perineuritis, interstitial neuritis, degeneration of ganglion cells and degeneration of nerve fibers. The nerve lesions may follow functional traumatism, pyogenic bacterial infection, pressure of tumors, epidemic cerebrospinal meningitis, ptomaine poisoning, mumps, influenza, syphilis, and the ingestion of certain drugs—quinine, salicylates, and wormseed oil. Treatment consists in absolute functional rest, full dose of strychnine by the mouth after the acute stage has subsided, and the use of iodide of potassium in the later stages to relieve the pressure from circulation in inflammatory cases.

The function of the cochlea is impaired to a marked degree by want of use over long periods, as is shown by the effect of long closure of the canal in an otherwise normal ear. The impairment of one ear acts through the association and decussation of the cochlear nerve fibers as a cause of impaired central and nerve hearing in the otherwise non-affected ear.

Cerebral Deafness.—The symptoms of cerebral deafness are similar to the preceding nerve deafness, with the additional symptom of retarded central reaction. The causes of the central deafness are local inflammatory or degenerative conditions of the auditory

tract or centers, tabes, poliomyelitis, and new growths. There are certain characteristic symptoms which give definite location to some of the lesions. The combination of the vertiginous and auditory symptoms locate the lesion where the cochlear and vestibular nerves are associated. The absence of the vertiginous symptoms and the presence of aphasic symptoms locate the lesion in the higher centers of the auditory sphere. The differential diagnosis between the inflammatory and the tumor or pressure conditions is made on the presence or absence of inflammatory signs. The treatment for the inflammatory conditions is removal of the cause, if possible, careful hygiene, and functional rest; for the tumor conditions, treatment is surgical removal of the tumor unless it be of luetic origin, in which case specific antisyphilitic treatment is indicated.

Deaf-mutism is dependent on defect of the sound-perceiving apparatus, which may be congenital or acquired at an early age before the habit of speech is established.

Etiology.—1. Congenital deaf-mutism is due to an absence or malformation of the sound-perceiving apparatus; 2. acquired deaf-mutism is due to lesions of the sound-perceiving apparatus, with or without lesions of the middle and outer ears. The defects must have arisen before the mechanism of speech was fully developed.

Pathology.—The congenital form is extremely rare. It is due to gross defect of the labyrinth, usually associated with absence of the middle ear and arrested development of the auditory nerve. The acquired form may be divided into the central and the peripheral. The central forms are the more common and are due to auditory neuritis of toxic or inflammatory origin. The toxic variety is due to poliomyelitis, ptomaine poisoning, and in rare cases to drug poisoning. The inflammatory variety is due to epidemic cerebro-spinal meningitis, measles, or scarlet fever. The peripheral form is due to inflammatory conditions originating in the middle ear, such as complications of measles, scarlet fever, and other fevers. Otitis media suppurativa in early life may cause deaf-mutism. The labyrinthine degenerations in this group are due to disuse except when there has been cochleitis.

Diagnosis.—The diagnosis is made independent of age if considerable deafness is present before speech has developed. The determination of deafness in young children is more difficult than in

adults. To determine the degree of deafness, the voice test should first be used by a member of the family. The child should be turned away and its attention absorbed by a third person, while the person making the test approaches from behind at a distance and calls to the child. If the child does not respond before the impact of the sound can be felt or the tremor of the approaching footsteps perceived, the child is very deaf. The next point is to establish the practical absence of hearing. This is best done by striking a gong or glass bowl at a short distance behind the preoccupied child. If the child does not turn immediately toward the source of sound, it is practically absolutely deaf.

Treatment.—The treatment is directed to improving the middle-ear conditions, with special attention to adenoids and nasopharyngeal obstruction, and to middle-ear inflation, if the membranes are depressed. The use of iodides is indicated for the benefit of the sound-perceiving apparatus.

Prognosis.—In a few cases classed as deaf-mutes, sufficient hearing has been restored by appropriate treatment to enable the children to advance in the usual way. Under favorable conditions—that is, with totally deaf-mute children of good mentality who receive constant individual care from an early age—the results of education will be good for comprehension of language, and in some cases for intelligible speech. There are on record a few cases of superior mental development in educated deaf mutes. Laura Bridgman and Helen Keller are examples of blind deaf-mute geniuses.

Education.—The education of deaf children who have never spoken should begin as soon as possible, not later than the seventh year. With children who have acquired the use of some words, every effort should be made at once to retain these words, since the difficulty of acquiring the use of language under these conditions is insignificant compared with the difficulty of teaching the first word. The greatest aid to instruction is the tactile sense of sound vibration, which is always present and which can be greatly developed.

Children who are backward in school are often suffering from deafness, and require proper aural treatment for improvement of hearing and instruction in special classes for their mental development.

AIDS TO HEARING, MECHANICAL AND ELECTRICAL.

A great variety of acoustical mechanical devices have been constructed to increase the volume of sound which reaches the tympanum. One principle of construction is a tube with a flaring orifice which fits into the external auditory meatus. The tapering part should be conchoidal for the best focusing and transmission of sound. The length of the tube and its form, whether straight or curved upon itself, is a matter of individual convenience.

Patients who have very good bone conduction may have their hearing efficiency increased by the use of a thin sheet of some elastic material, such as hard rubber or even paper. The patient should place one end of the sheet against the teeth and bend the sheet so as to make it tense. It will then respond to the sound vibrations of air, which will be carried to the cochlea by bone conduction.

The micro-telephonic devices now in use as aids to hearing prove very satisfactory, especially in cases which have proportionately great deficiency in high tone perception.

The general principle in selecting an aid to hearing is that the patient should try various hearing devices before selecting one, since individual peculiarities cannot always be determined without a practical test.

The devices used to improve middle-ear sound transmission are described in the chapters on Physiopathology and Suppurative Middle-ear Diseases.

DISEASES OF THE ORGAN OF EQUILIBRATION OF THE VESTIBULAR MECHANISM.

Owing to the close connection of the vestibular nerve and its roots with the motor and sympathetic nerve tract, disturbances of these functions are always found with severe irritation of the vestibular nerve, producing circulatory, gastric, motor-ocular, and musculo-dynamic disturbances. The symptoms of the disturbance of the vestibular apparatus are either false reaction—para-equilibrium, oversensitiveness—hyper-equilibrium, or loss of sensitiveness—hypo-equilibrium.

Para-equilibrium.—The presence of this condition is evidenced

by vertiginous symptoms which may be associated with nystagmus, great muscular weakness, and vomiting. These symptoms show irritation of the vestibular apparatus without sufficient functional stimulation.

Hyper-equilibrium may be present without any active signs of inflammation or other irritation. This hyper-sensitiveness is demonstrated by causing the patient to perform some movement which brings the vestibular apparatus into action. The simplest way is to cause the patient to stand erect and rapidly turn upon his heels from one to four times. If he shows evidence of loss of equilibrium after one or two turns, hyper-sensibility is demonstrated. A stool with a rotary seat is very convenient for the test.

Hypo-equilibrium.—To demonstrate the lack of sensibility, the patient is told to close his eyes and stand erect, while the observer turns him rapidly on his heels. If there is no vertiginous reaction after three or four turns, the vestibular apparatus is paretic. If on continued rotation no vertiginous symptoms appear, the vestibular apparatus is paralyzed.

Nystagmus.—Nystagmus is developed in the direction of the rotation in individuals with a normal vestibule by rapidly rotating the person to the right or left four or five turns. After the cessation of the rotation the nystagmus is reversed and occurs in the opposite direction to the rotation. Nystagmus is an accompaniment of vertigo in physiological and pathological conditions.

Increased nystagmus is an important symptom of labyrinthine disease with vestibular irritation. With an irritated labyrinth the nystagmus is most marked toward the irritated side. With extreme vestibular irritation nystagmus is present without external stimulation. With a less degree of vestibular irritation and a high degree of latent nystagmus, the nystagmus is developed by causing the patient to turn the eyes toward the diseased side. In a less degree of vestibular irritation and a less degree of latent nystagmus, nystagmus is developed to an abnormal degree by rapidly rotating the patient several times. After rotation toward the diseased side, straining the eyes in the opposite direction will develop an exaggerated nystagmus.

With abnormal vestibular irritability rotation toward the affected side develops nystagmus more quickly than with a normal vestibule; and, after cessation of the rotation reverse nystagmus is developed

to a greater degree than with a normal vestibule. With a recently paralyzed labyrinth nystagmus is most marked toward the healthy side as if it were abnormally irritable. Vertiginous symptoms follow anomalies of intratympanic tension and change in labyrinthine circulation, just as tinnitus occurs in the cochlea under similar circumstances. Nystagmus sometimes occurs independent of labyrinthine disturbances.

DISEASES OF THE LABYRINTH AS A WHOLE—THE INNER EAR.

Injuries of the Inner Ear due to Heavy Detonation and Concussion.—Heavy detonation and concussion rupture the drum membrane usually in the posterior superior quadrant and also rupture the membrana tympani secundaria and the orbicular ligament of the stapes and cause severe injury to the labyrinthine structures.

Diagnosis.—The diagnosis is made on the history of traumatism with evidence of a tear in the drum membrane and symptoms of severe labyrinth impairment.

Treatment.—Treatment is rest in bed on light surgical diet with a light cotton plug in the meatus which is to be kept dry. If signs of infection develop, treatment is carried out as in labyrinthine and middle-ear infection.

Prognosis.—The prognosis is good for speedy recovery in uninfected cases with more or less permanent destruction of the function of the labyrinth. With infection, the prognosis is grave.

Injuries of the inner ear complicated by fracture of the base of the skull. The ear symptoms differ with the extent of the injury, the organs ruptured, the amount of the hemorrhage and the amount of serous leakage. The pathognomonic sign of fracture of the bone is the split in the inner end of the canal, usually the upper part, which involves part of the drum membrane. The patient may show nothing more than the symptoms of middle-ear injury, or he may have cochlear and vestibular symptoms together with symptoms of intracranial concussion and hemorrhage. Later, septic and inflammatory symptoms may be superadded.

Treatment.—The patient is put to bed, even if there are no subjective symptoms. The first treatment indicated is asepsis. If the ear is dry it should be lightly plugged with cotton and let

alone. If the ear is moist it should be wiped dry, washed with alcohol, again wiped dry, and securely plugged with sterile absorbent cotton. The nose and pharynx should be attended to in order to promote tubal drainage. If the leaking of fluid continues from the ear, dry sterile wicks should be kept constantly in the meatus. As the fluid decreases, boric acid powder is insufflated into the canal. The meatus is kept plugged until the wound is entirely closed. If infection and inflammation sets in, it must be treated as otitis media and interna, with intracranial complications. The complications of injury of the labyrinth are rare.

Panotitis is the term used to denominate an infection of the inner and middle ears. It is characterized by the combination of middle ear, cochlear and vestibular symptoms, together with the constitutional symptoms of infection. The treatment is indicated by the extent of the disease, which requires attention first to the middle and inner ears, and afterward constitutional treatment.

As has been said, the vestibular apparatus is often affected in connection with the cochlea, and the symptoms of the two affections naturally occur together. This is particularly noticeable in the symptom complex known as *Ménière's disease*, which has no special pathological basis. The complex is made up of vestibular and cochlear symptoms—vertigo, vomiting, deafness, and tinnitus. The whole labyrinth may be involved in a suppurative process—a complication most often seen in the exanthemata of childhood. The labyrinth has a remarkable power of limiting infection or poison to small areas. Part of the cochlea or part of the vestibule may be destroyed and thrown out as a sequestrum, without any injury to the remainder.

Hyperemia and anemia of the labyrinth, with signs of disturbance of the cochlear and vestibular equilibratory functions are due to defects in the vasomotor mechanism from constitutional or nasopharyngeal causes. They quickly yield to treatment after the removal of the cause.

The labyrinth may become invaded by non-suppurative disease originating in the middle ear. Otosclerosis affects the bone of the labyrinth capsule. It may continue and disturb the labyrinth, and especially the cochlea by exostoses impinging on the membranous labyrinth. The cochlear apparatus is more often disturbed by the pathological conditions in the nose and throat and by the extension

in otosclerosis than is the vestibular apparatus. On the other hand, the peripheral organ of equilibration, or the vestibular mechanism and the equilibrational tract, are less susceptible to toxic injury or reflex disturbances than the auditory or cochlear peripheral organ and tract. On account of the varying susceptibility of the two divisions of the labyrinth, infection often reaches the vestibule before it does the cochlea. Invasion of the vestibule takes place through the external semicircular canal, which is sometimes perforated as a complication of otitis media.

The vestibular apparatus is also more often affected by constitutional disturbances, by bacterial invasion, and by irritation of the vagus, than is the cochlear apparatus. These facts are shown by the frequency of vertiginous symptoms with general disorders, and the frequency of infectious labyrinthitis with vestibular involvement. The cochlea is seldom so disturbed.

In other respects the pathology of the auditory and equilibrational mechanisms is identical.

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CHAPTER XXXIV.

THE MAJOR SURGICAL DISEASES OF THE EAR AND THEIR COMPLICATIONS.

MASTOIDITIS.

Etiology.—Mastoiditis is due to the extension of the inflammation of the mucous lining of the middle ear to the bony walls and cells of the antrum and to the mastoid cells. Occasionally the development of mastoiditis is due to traumatism or to direct extension of some external inflammation, such as lymphadenitis and otitis externa.

Symptomatology.—In the order of their frequency the symptoms are pain, tenderness, pyrexia, rapid pulse, and swelling in the mastoid region. Any of these may be lacking in certain cases, in which event circumstantial evidence will indicate mastoiditis. The circumstantial evidences of mastoiditis are febrile conditions, increased pulse rate, a temperature above 99°, coated tongue, loss of appetite, and general weakness, without any cause more probable than the infected ear. If a subacute or chronic purulent otitis is present, or if there is a history of a recent attack of otitis, these febrile symptoms become positive evidences of mastoiditis.

Diagnosis.—When there is active middle-ear inflammation or a history of a recent otitis media, the diagnosis is made on the evidences of periostitis over the mastoid region, as shown by deep swelling, or on the evidence of periostitis in the canal, shown by narrowing of the canal and drooping of the posterior superior inner osseous wall of the canal. The diagnosis is also positive when there is pain which increases on deep pressure over the posterior end of the digastric fossa or over the mastoid antrum, and with history of middle-ear inflammation. If none of the above signs is present, but if there is a history of an aural infection followed by a persistent pyrexia, rapid pulse and an increased differential polymorphic leucocyte count, which cannot be explained by disease of some other origin, a positive diagnosis of mastoiditis is made.

The *differential diagnosis* from otitis externa, mastoid adenitis, parotiditis, and angioneurotic edema. In otitis externa there is tenderness and swelling of the cartilaginous auditory canal and an extra-periosteal swelling and tenderness. Mastoid adenitis is characterized by extra-periosteal swelling over the mastoid process, not often associated with middle-ear inflammation. The swelling of parotiditis is extra-periosteal, and most developed over the parotid glands. Angioneurotic edema fluctuates without any apparent local cause, and the swelling may move from place to place.

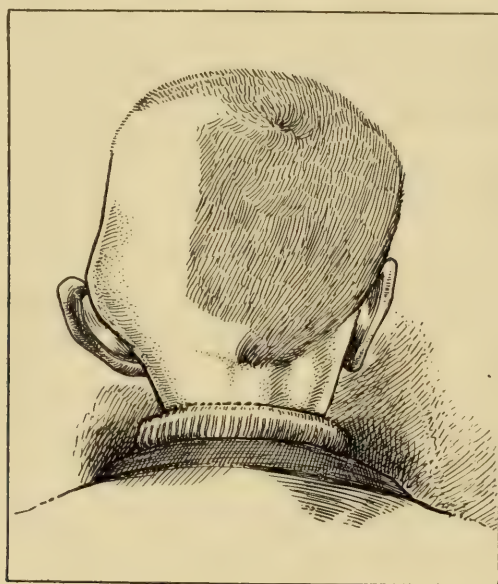


FIG. 213.—Patient with mastoiditis with subperiosteal abscess, showing mastoid swelling and displacement of auricle, compared with normal side, viewed from behind.

Prophylaxis.—The prophylaxis of mastoiditis is achieved by prevention of middle-ear infection, and by early and efficient treatment when the infection has taken place.

Treatment.—If the symptoms of the mastoiditis are not far advanced, and there is any definite objection to operative interference, expectant treatment can be followed on these lines—establishment of free tympanic drainage through the meatus by extensive myringotomy, saline laxatives, rest in bed, normal salt solutions by the mouth or rectum, artificial leeching over the mastoid process, douching of the auditory canal with saturated aqueous solution of boric acid of temperature 100° to 110° every hour, and applications of heat over the mastoid region.

Indications for Operation.—As soon as the presence of mastoiditis is definitely established, operative treatment will afford the best results in point of speedy recovery and restoration of hearing. An operation before the constitutional symptoms indicate toxemia or the local external signs show softening will prevent further complications.

Prognosis.—If an early operation is performed, the prognosis is good for complete recovery in from one to three weeks with re-establishment of normal hearing. Without operation, the prognosis is for slow recovery with impaired hearing, with the development of serious complications in a few cases. The complications, if not efficiently managed, result fatally.

Complications.—The complications of mastoiditis are subperiosteal abscess, osteomyelitis, labyrinthitis, epidural abscess, sinus thrombosis, pachymeningitis, perisinus abscess, subdural abscess, leptomeningitis, cerebrospinal meningitis, brain abscess, metastatic abscess, toxemia and bacteriemia. One of the most usual complications of mastoiditis is osteomyelitis, which is inflammation of the bone-marrow associated with softening of the bone. The inflammation extends widely through the temporal bone, and requires extensive bone excavation for its removal.

INFECTIOUS OTITIS INTERNA.

Etiology.—Infectious otitis interna is due to an extension of a tympanic inflammation into the labyrinth, or to an extension of inflammation of the meninges into the labyrinth.

Symptomatology.—The symptoms, if the cochlea is affected, are rapidly increasing deafness and loss of bone conduction. If the vestibular apparatus is affected, the vertiginous symptoms are very marked. In either case, the symptoms are associated with indications of constitutional infection and rise of temperature.

Diagnosis.—The diagnosis is made on the above marked symptoms, in connection with either meningeal or tympanic inflammation.

Prophylaxis.—Prophylaxis consists in the avoidance of intracranial or tympanic inflammations, or if these inflammations have already occurred, in their successful management.

Treatment.—Tympanic drainage, with rest in bed and saline laxatives, can be tried for a short time before operative interference

is inaugurated. A continued septic temperature with rapid pulse, and the above symptoms after the establishment of tympanic drainage or increasing gravity of the symptoms, are indications for operation.

Prognosis.—The prognosis is for partial or total loss of function. In a few cases, usually in adult cases, fatal intracranial complications develop. After operation the intracranial complications are much less frequent, and the prognosis is proportionately better.

Complications.—The complications of labyrinthitis of tympanic origin are intracranial inflammations, meningitis, and brain abscess.

INTRACRANIAL COMPLICATIONS OF DISEASES OF THE EAR.

PACHYMEINGITIS, EPIDURAL ABSCESS, PERISINUS ABSCESS, SUBDURAL ABSCESS.

Etiology.—Pachymeningitis, epidural abscess, perisinus abscess, and subdural abscess are due to the extension of infection from the tympanum. This infection usually passes through the mastoid cells to the sigmoid groove, or more rarely through the tegmen into the middle fossa, or through the labyrinth into the cerebellar fossa.

Symptomatology.—The symptoms are exaggerated forms of those present in middle-ear and mastoid inflammations. If the focus of the complication is in the neighborhood of the emissary vein, the headache and tenderness over the emissary vein are more marked than is usually the case with uncomplicated middle-ear and mastoid inflammation. If the focus is in the middle fossa the temporal headache may be extreme.

Prophylaxis.—The prophylaxis is an early mastoid operation.

Treatment.—The treatment is operative. The indications for operation have been long neglected by the time any intracranial complications of mastoiditis are apparent.

Prognosis.—The prognosis is good for recovery after early operation, and bad for further intracranial complications without operation.

Complications.—The complications are further intracranial extension, the chief development being sinus phlebitis and thrombosis.

SINUS PHLEBITIS.

Sinus phlebitis of the intracranial sinuses and veins becomes *sinus thrombosis* when the inflammation has advanced to desquamation of the endothelium, and to formation of thrombi. Sinus thrombosis is designated primary when the infection invades the sinuses directly from the infected tympanum, and secondary when it proceeds through the infection of the mastoid cells to the sinus. The sinuses primarily involved are the sigmoid, lateral, inferior and superior petrosal and jugular bulb. All the remaining sinuses and jugular vein may be involved secondarily. The cerebral veins are also subject to phlebitis of otitic origin.

Etiology.—Phlebitis and thrombosis are caused by extension of inflammation from the tympanum and mastoid cells into the walls of the adjacent sinuses and veins. The phlebitis and thrombosis extend with and against the blood stream.

Symptomatology.—The symptoms may be very obscure. In typical cases they consist in the repeated high rise and fall of the temperature curve, and in the presence of streptococcemia and metastatic abscesses.

Diagnosis.—The diagnosis is positive upon the present or recent history of ear infection, with the characteristic saw-toothed temperature curve, or upon the discovery of streptococcemia, provided, of course, that there is not a more obvious cause for the constitutional symptoms in some other organ. Cavernous sinus thrombosis makes itself evident by the swelling and edema of the upper part of the face and by exophthalmos, due to the backing up of blood from the cutting off of the intracranial return flow. The diagnosis may be very difficult, owing to the suppression of symptoms of phlebitis and thrombosis.

Differential Diagnosis.—It is sometimes difficult to make a differential diagnosis between cavernous sinus thrombosis, of otitic origin, and cavernous sinus thrombosis of nasopharyngeal origin. The points to be noted are, the condition of the ear and nasopharynx. If the ear gives no local signs of infection which might be the cause of local thrombosis and the nasopharynx shows an infected condition, the diagnosis of thrombosis, of nasopharyngeal origin, is warranted. But, on the other hand, with a suppurating ear, the probabilities are very much in favor of an otitic origin for

the thrombosis independent of nasopharyngeal infection. Nasopharyngeal thrombosis is of rare occurrence.

Prophylaxis.—Prophylactic measures consist in the early treatment of the middle-ear infection and in a timely mastoid operation.

Treatment.—Treatment is operative. The operation should not be delayed.

Prognosis.—With early operation, the prognosis is good for recovery. A fatal issue may be expected if the cerebral vessels are extensively thrombosed, or if the thrombosis extends into the innominate veins.

Complications.—Complications to be feared are streptococcemia, extension of the thrombosis, brain softening, brain abscess, and metastases.

LEPTOMENINGITIS AND INFECTIOUS HYDROCEPHALUS AND PYOCEPHALUS.

Leptomeningitis, or inflammation of the meninges within the dura mater, and of the ventricles of the brain, is either serous or purulent. Serous meningitis is characterized by external or internal hydrocephalus, which may be localized, or may extend through the brain and spinal cord. Purulent leptomeningitis and internal pyocephalus may be confined to the vertex or the base; they may be diffuse or located in a subdural abscess or ventricle or they may extend through the brain and spinal cord.

Etiology.—These inflammations are due to delayed mastoid operation and to the spread of infection from the middle ear to the pia, arachnoid and ventricles.

Symptomatology.—The symptoms are a constant rise of temperature ranging from 100° to 103° for the serous meningitis and from 103° to 107° for the purulent meningitis. Other symptoms of the disease are due to intracranial irritation and compression, associated with middle-ear disease. The symptoms of the two forms are similar except that in the purulent form the symptoms are more marked. These symptoms may be considered under two heads: first, the symptoms arising anterior to the tentorium and, second, those arising posterior to it. It must be borne in mind, however, that as the pathological condition becomes more grave, a lesion with its seat on either side of the tentorial wall will cause symptoms

referable to the brain on the other side. Symptoms from in front of the tentorium are due to cerebral irritation and compression. These symptoms in cerebral irritation are severe headache and mental irritability. The symptoms indicating compression are choked disk; irregular, uneven pupils; pupils that react to distance and not light; contracted pupils, and coma. Posterior to the tentorium the symptoms from irritation are compression as shown in alteration of the neuro-muscular phenomena; rigidity of the muscles; resistance to motion of the various joints, especially noticeable in movement of the neck and of the leg on the flexed thigh; incoordination of motion shown by inability to approximate the finger of the two hands with the eyes shut; increase or obliteration of tendon reflexes; vertigo, vomiting, and muscular incoordination and weakness.

Localized meningitis may indicate its location by its influence on the function of local structures. When the meningitis is located about the left fissure of Rolando, motor paresis and paralysis is produced. Various paralyses of the extrinsic muscles of the eyes are found in meningitis of the base. Other cranial nerves also show effects of the meningitis. Optic neuritis is sometimes marked.

Lumbar puncture will usually indicate increased cerebrospinal tension. In the purulent cases bacteria are usually found in the cerebrospinal fluid.

Diagnosis.—The diagnosis is made upon the continued high temperature, intracranial irritation and indications of increased intracranial tension in connection with middle-ear infection. In internal pyocephalus pus is found in the cerebrospinal fluid.

Prophylaxis.—Prophylactic measures consist in early mastoid operation and attention to the primary middle-ear infection.

Treatment.—Treatment is operative for the relief of intracranial compression, cranial drainage of the infected area, and spinal drainage through lumbar puncture.

Prognosis.—The prognosis is good for speedy recovery after drainage in the serous form; it is bad for purulent meningitis. Without operation purulent meningitis is always fatal.

Complications.—The complications are cerebrospinal meningitis and brain abscess.

INFECTIOUS ENCEPHALITIS OR INFLAMMATION OF THE BRAIN TISSUE—BRAIN ABSCESS.

The pathology of infectious encephalitis includes non-suppurative or serous brain inflammations, tissue necrosis, brain softening, interstitial suppuration, and circumscribed brain abscess. The changes occur in several stages, viz., serous inflammation; necrosis of thrombotic origin, coagulation necrosis, followed by tissue softening, and finally suppurative inflammation. The gross appearances are local hyperemia and serous exudation, gangrenous necrosis of the brain and meninges, cerebellar abscess and cerebral abscess.

Etiology.—The infection extends from the middle ear usually by means of phlebitis; more rarely by direct interstitial extension.

Symptomatology.—The symptoms are those of septic infection with low or medium temperature, 99° to 101°, associated with an infected ear as primary cause. The symptoms pointing to the intracranial seat of the lesions are, increased intracranial irritation and compression, choked disk, falling pulse rate with rising temperature and severe headaches. Cerebral abscess may have focal symptoms from the part of the cerebrum involved. These symptoms are aphasia, motor impairment, paralysis, etc. Cerebellar abscesses sometimes have marked coordinational defect and alteration of the tendon reflexes.

Diagnosis.—The symptoms of brain abscess are too indefinite to permit a positive diagnosis. The confirmation of the diagnosis should be tentative until operation. In the presence of focal symptoms the diagnosis is positive.

Treatment.—Treatment is operative.

Prognosis.—With early operation, the prognosis is for recovery in 50 per cent. of the cases. In delayed operation, the disease is usually fatal.

Complications.—The complications are leptomeningitis, cerebrospinal meningitis, and septicemia.

SYSTEMIC COMPLICATIONS OF MAJOR SURGICAL DISEASE OF THE EAR.

Mild inflammations and suppurative inflammations, usually in the larger joints and occasionally in the pleura, are the forms of metastatic inflammation of ear infections.

Etiology.—The metastatic infection is due to metastatic spread and implantation of infection from otitis media, or its complications.

Diagnosis.—The diagnosis is made on the local symptoms of infection in connection with the history of primary disturbances in the ear.

Prophylaxis.—The prophylaxis consists in early mastoid operation.

Treatment.—The treatment consists, first, in the care of the middle ear and its complications; second, in general constitutional treatment, and third, in local and operative treatment of the metastases. The indication for operation is determined by the local conditions.

Bacteriemias developing from ear diseases usually appear in the form of streptococcemia, and indicate sinus phlebitis and thrombosis.

Etiology.—In these diseases streptococci have passed from the middle ear to the veins and have entered the general circulation.

Symptomatology.—The symptoms are high, saw-toothed temperature curve, with bacterial findings in the blood.

Diagnosis.—The diagnosis is determined by the high, rapidly fluctuating, febrile temperature and by the bacterial findings.

Prophylaxis.—The prophylaxis consists in early tympanic drainage and mastoid operation.

Treatment.—The treatment is directed to local management of the ear and its complications; anti-streptococcic serum may be tried. Large quantities of water should be given by the mouth, saline laxatives, and rest in bed.

Prognosis.—The prognosis is bad for recovery.

TOXEMIA.—Toxemia from ear disease is due to the passage of toxins from the infected ear into the general circulation. The symptoms are a coated tongue, yellow skin, fetid breath, extreme weakness, high temperature, and weak, rapid pulse.

Treatment.—The treatment consists in the eradication of the local cause, the free use of potable water by the mouth, of normal salt solution by the mouth and rectum, and of repeated small doses of magnesium sulphate, (about half-dram).

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CHAPTER XXXV.

NASOPHARYNGEAL AND CONSTITUTIONAL TREATMENT OF EAR DISEASE.

The vital importance of nasopharyngeal conditions as etiological factors in ear affections has been emphasized in the previous chapters. The grosser rhinopharyngeal conditions, such as occlusion of the nasal fossæ, hypertrophies, osseous and cartilaginous deformities, new growths, and suppurative infections, have been thoroughly considered by Dr. Knight.

There are, however, several minor disturbances of the nasopharynx which, since they are often the cause of the most stubborn cases of ear diseases, deserve especial attention. Under this head we may group mild disturbances of the fossa of Rosenmüller, of Luschka's tonsil and the pharyngeal bursa, alteration of the circulation of the mucous membrane, and contact of mucous surfaces, especially contact between the outer surface of the lower turbinate and the nasal wall. These conditions affect the ear unfavorably by mechanical, inflammatory, toxic, and reflex disturbances.

The lining of the fossa of Rosenmüller is subject to local hypertrophy, infection, and adhesions with cicatricial contractions. These alterations, with the exception of the infections, interfere with the physiological movements—opening and shutting—of the pharyngeal mouth of the tympano-pharyngeal tube. We have already considered the effects of impaired tubal action on the ear.

Luschka's tonsil and the pharyngeal bursa are often irritated or infected without showing much superficial change. Irritation of this region has, however, a marked reflex action upon the tympanic nerves, both through the nervous reflexes and through the local toxic effects on the sympathetic ganglia.

The caliber of the Eustachian tube is subject to constriction by congestion of the mucous membrane, which extends into the tube from the nasopharynx and participates in the same changes as in the larger cavity. Contact of the mucous surfaces, especially of the outer surface of the lower turbinate and the nasal wall, has

marked influence on the ear by clogging the Eustachian tube. This obstruction of the tube is probably brought about by disturbances in the circulation. The minor mechanical disturbances of the nasopharynx also interfere with the functions of the Eustachian tube. The minor inflammatory conditions interfere with the action of the tube by thickening the membrane, and predispose to otitis media by lowering the local resistance and by supplying the infecting organism.

Reflex circulatory disturbances of the tympanum may originate from any pharyngeal irritation. The circulatory disturbances also follow the impairment of the sympathetic ganglion cells often accompanying minor infections of the neighboring membrane.

The treatment for the minor nasopharyngeal conditions differs only in degree from that prescribed for the grosser conditions.

CONSTITUTIONAL TREATMENT.—Next to nasopharyngeal influences, the constitutional influences are the most important factors in causing ear disease. These constitutional influences act in two ways: first, through disturbances of the mucous membrane in the nasopharynx, which in their turn affect the ear; and, second, through the blood stream, by disturbing the nutrition and conveying toxic material to the ear.

All constitutional conditions which lower the vitality and are accompanied by toxic phenomena have a three-fold injurious effect upon the ear. First, by their alteration of the functions of the mucous membrane they disturb the action of the Eustachian tube. Second, by lowering the resistance they subject the middle ear to the infection which the altered mucous membrane cannot resist. Third, by their toxic effect upon the nervous supply of the ear, they cause trophic changes and thereby render the ear less able to resist the infection. The effect on the auditory nerve ganglion causes a hypersensibility and impaired function. The disturbance of the sympathetic system causes tympanic mucous membrane changes.

Minor constitutional disturbances, digestive disturbances, anemia malnutrition, and nervous fatigue have an undoubted injurious effect upon the ear. Digestive disturbances frequently cause congestion of the mucous membrane of the tube and atrium, and consequently disturb the acoustic balance. Constitutional anemia and malnutrition may emphasize local anemia, with accompanying

impaired function of the middle ear and cochlea. The anemia often causes atrophic changes.

The delicate adjustment of the neuro-muscular mechanism of audition requires the expenditure of considerable nervous force for the performance of delicate functioning. After general nervous exhaustion the supply of nerve force is so reduced that the demands of the auditory apparatus cannot be met, and consequently the function is impaired.

The treatment of the constitutional conditions producing ear disease is naturally the usual treatment for ear diseases. Where the constitutional disturbances are of a minor nature, they require the general hygienic management which such disturbances demand, regardless of the ear complications. This treatment includes tonics, rest, and intestinal regulation. The toxic condition of the ganglion of the auditory nerve may be out of proportion to the constitutional symptoms of toxemia, which gives the ear symptoms marked prominence. This is sometimes the case with systemic bacterial intoxication but more often with drug toxemia—notably with quinine, salicylates, tobacco, alcohol, etc. The treatment is, first, removal of the cause.

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CHAPTER XXXVI.

SURGICAL TECHNIC.

MAJOR AURAL SURGERY.

Mastoid Surgery.—Mastoid surgery is directed to thorough drainage and complete evacuation of the infected tissues through their whole extent and ramifications, commencing at the mastoid and extending into the brain and neck. All operations for mastoiditis and its complications are begun with the same technic. The course and details of the operation cannot be foretold except in a small proportion of cases. Such procedures are followed as the disclosed inflammatory conditions demand.

Previous to the operation, the bowels should be evacuated by a dose of 4 grains of calomel to the average patient, followed in two hours by a saline laxative, one-half ounce of magnesium sulphate, and in two hours by a soapsuds enema. A careful physical examination of the heart and lungs and a urinary analysis are absolutely necessary before the administration of an anesthetic. In order to avoid the mental shock of walking into the operating-room, the patient should be put under primary anesthesia in his bed. After the commencement of the anesthesia, an area not less than two inches wide all around the ear should be shaved clean. With women, after the shaving, the hair is carefully drawn back from the scalp and a strip of gauze an inch wide applied along the hair margin with flexible collodion. This is a very useful measure during the postoperative dressings, as it keeps the hair from the wound.

The general technic in ear surgery is similar to that used in other branches of surgery. Rigid asepsis and antisepsis is an absolute necessity if good results in aural surgery are to be obtained. It is desirable to have the operative field sterile as in abdominal operations, and as much effort should be bestowed upon the aural field, especially as its anatomical configuration makes it particularly hard to sterilize. The skin is sterilized by Harrington's solution,

which is washed off in three minutes with sterile water. The canal is then syringed with alcohol and packed with gauze.

Sterile instruments and sterile dressings are a necessity. If the operator handles the wound, he should protect the patient by wearing rubber gloves. In doing mastoid work, he should also wear a cap, a veil, and a sterile gown with sleeves.

The surgeon must take every possible precaution not to infect sterile tissues and cavities. If infection already exists, it must

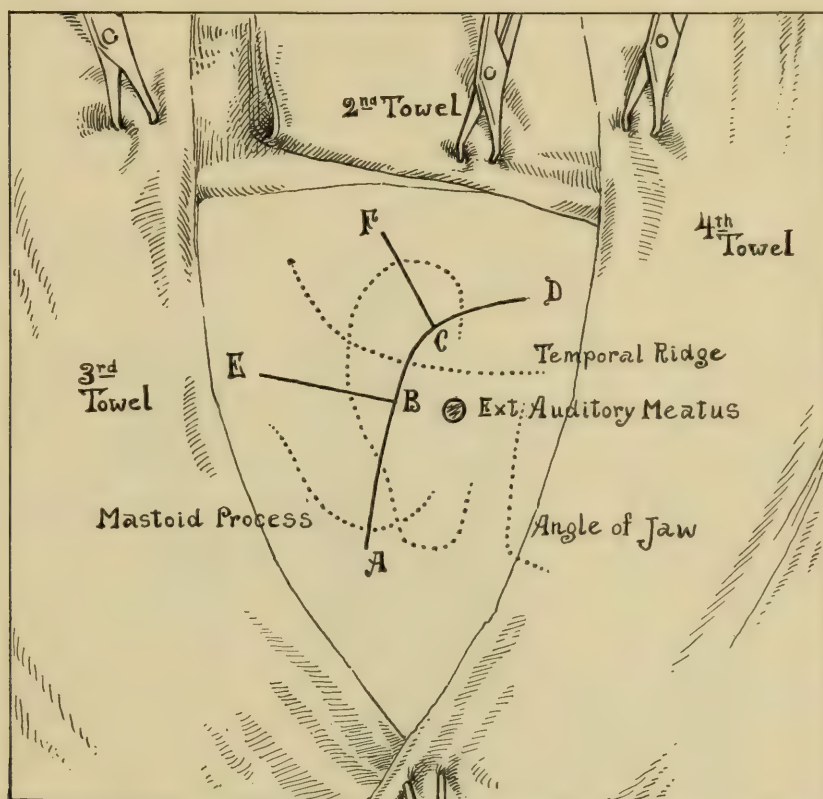


FIG. 214.—Shows adjustment of towels about operative field, lines of different incisions and landmarks; 2. first towel wrapped around head, covering hair; 3. second towel to protect the back part of head and neck; 4. third towel, covering face and field of anesthesia. The different cuts are AB, AC, AD, ABE, ABCE, ABCDF

not be complicated by adding new species of pathogenic bacteria, since the complication of the infection greatly increases the virulency of the disease.

A sterile sheet is placed on the patient up to the neck. In order to protect the wound, sterile towels are placed in the following positions: One towel, towel No. 2 of the figure, is wound around the head to cover the hair. Towel No. 3 is fastened to towel No. 2 and to the sheet; this forms the posterior protection of the

operative field. Towel 4 is fastened to Towel 2 at the top of the sheet, thus forming the anterior protection of the operative field. This towel forms the barrier between the operative and anesthetic fields.

Since in most cases it is impossible to foretell the extent of an aural infection before exploration, it is not wise to plan the exact extent and character of any operation to be performed. It is better to begin systematically to remove the diseased tissue and to explore the extent of the involvement, prepared to follow out any complications that are disclosed. In every case, all the air cells should be opened to prevent postoperative extension and recurrence. The wound should be irrigated from time to time with isotonic salt solution in order to keep it damp and clear of blood.

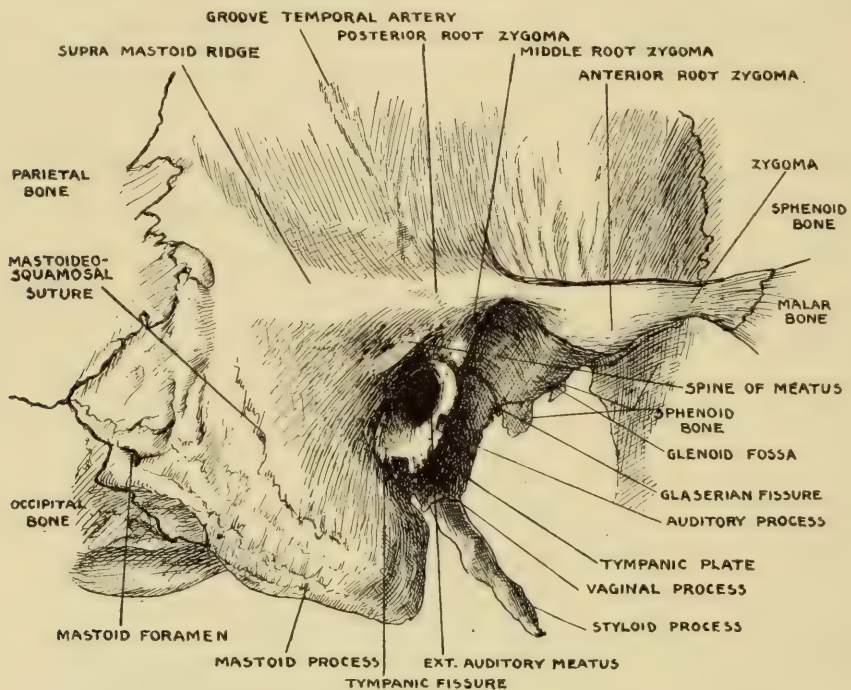


FIG. 215.—Outer Surface of Right Temporal Bone.

Before commencing the mastoid operation, it is wise to thoroughly incise the drum membrane. The mastoid incisions are extended as the conditions require, from A to B, B to C, B to E, C to D, and C to F. The primary incision, AB (Fig. 214), is made through the skin down to the periosteum. When the bleeding is controlled, the periosteum is cut and carefully lifted in unbroken sheets with the periosteum elevator, pushing the flaps forward and backward, and removing with them the attachment of the sternocleidomastoid mus-

cle. The tip of the mastoid process is now exposed and the periosteum separated from the under and inner surface by passing the periosteum elevator underneath the tip, well up into the digastric fossa. The bleeding is controlled, the retractors are adjusted and the tip of the process is completely removed by the use of a larger rongeur (Fig. 216).

If the appearance of the bone suggests an extension further than the simple involvement of the mastoid process, a cut, BC (Fig. 214.), is

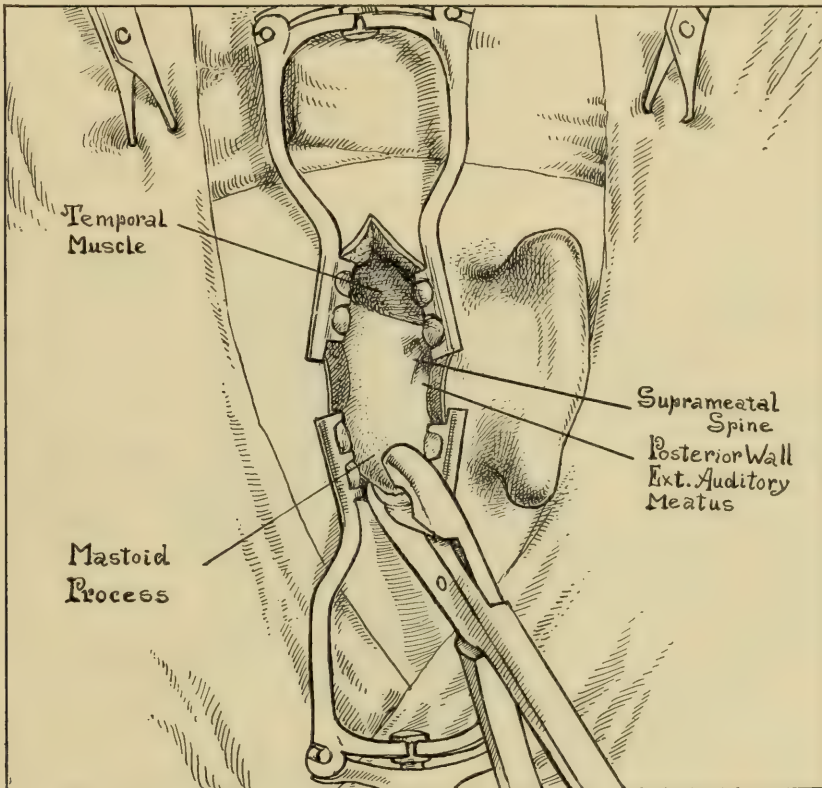


FIG. 216.—Commencement of a Mastoid Operation. Adjustment of the retractor. Exposure of the cortex of the mastoid process, retraction of flaps and morcellment of the mastoid tip with the large rongeur.

added. If there is posterior extension, the cut in the direction BE (Fig. 214) is also made, and the periosteum carefully lifted from the bone. As much of the diseased area as possible is removed with the large rongeur and with the smaller rongeur (Fig. 229, No. 1). In ordinary cellular bones, these instruments are sufficient to remove the external cortex and mastoid cells and to thoroughly open the antrum.

Fig. 217 shows a bone like Fig. 215, after the tip of the mastoid process and the outer cortex have been removed, all the cells and

the antrum have been opened with the rongeur. It must be emphasized again that the infected areas must be sought, followed out and completely removed. In the particular specimen shown in Fig. 217, the cellular area has extended down from the mastoid region into the jugular process of the occipital bone as far as the condyle. The edges of the bone wound should be carefully levelled and two-thirds of the posterior meatal wall removed, in order to leave as smooth a surface as possible for the reception of the skin flap.

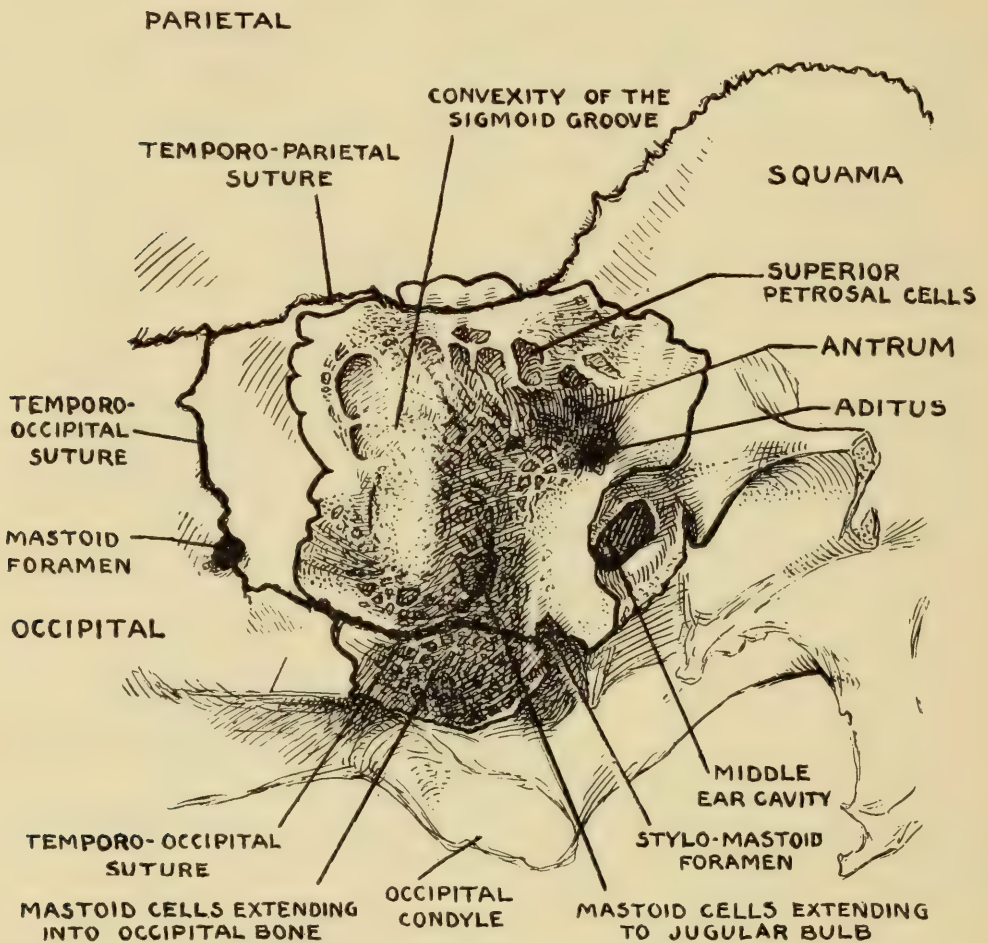


FIG. 217.—Complete Mastoid Operation.

Before closing the wound, the bone surfaces should be smoothed with a Richard's curette (Fig. 229, No. 22) and the bony trabeculae completely removed. Through the posterior wall of the membranous canal, a slit should be cut from the inner end of the bony canal to the external meatus (see Fig. 223).

In the rare cases in mastoid operations, in which the sigmoid sinus has such an extreme anterior position that there is not room enough

to enter the antrum between the groove of the sinus and the posterior wall of the auditory canal, the sigmoid sinus and the neighboring dura is denuded of bone and pressed out of the way to allow free access to the antrum.

Fig. 218 shows the same bone when the involvement has extended forward to the epitympanum. This involvement requires what is called a "modified radical operation." The ossicles are left in position, the outer wall of the epitympanum is removed down to

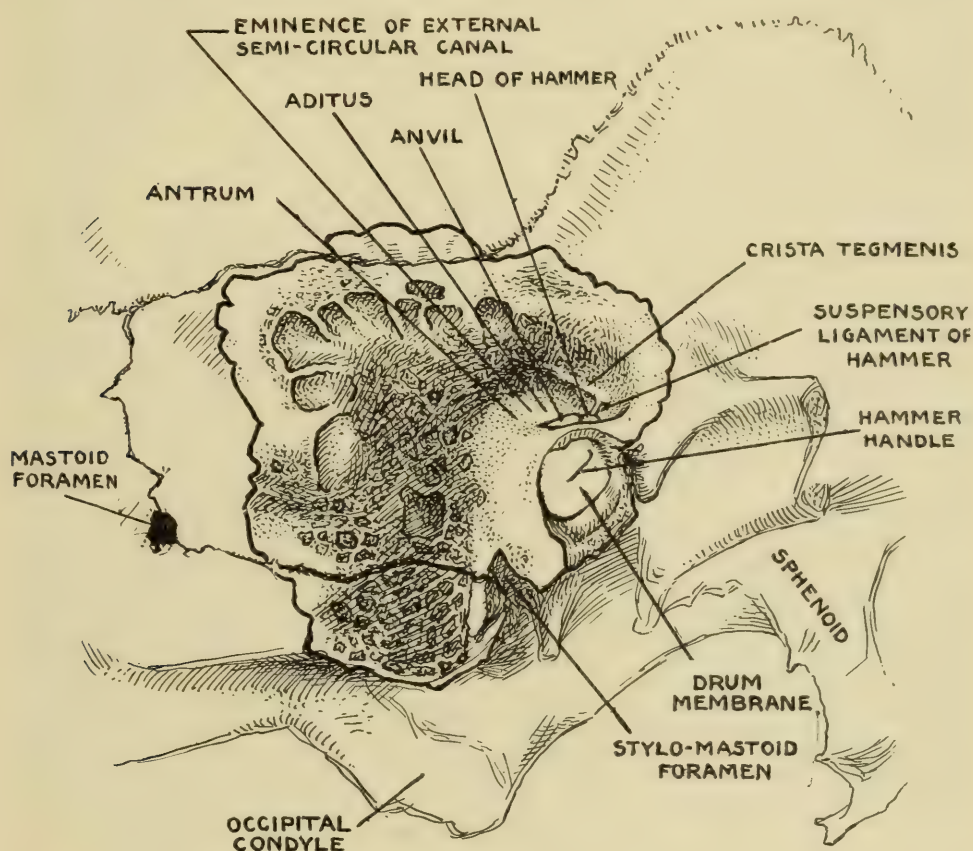


FIG. 218.—Same bone. Author's modified radical mastoid operation. The outer wall of the epitympanum has been removed, leaving the ossicles in position. All the work done on the bone shown in the figure was done with rongeurs.

the attachments of the ossicles and the posterior wall of the osseous canal down to the attachment of the drum membrane and the safety line of the facial nerve. This nerve lies internal to a line connecting the stylomastoid foramen and the sula incudis, the posterior attachment of the incus.

Fig. 219 shows the same bone where it was necessary to perform what is called a "radical operation," because of the presence of extensive bone involvement in the tympanum as well as in the

mastoid. In this case part of the upper anterior tympanic wall, all of the upper external wall, and as much of the posterior meatal wall as the position of the facial nerve would allow have been removed. The same specimen shows some small zygomatic cells opened.

Previous to the operation this case showed constitutional symptoms of thrombosis of the sinuses. When the bone was opened a diseased tract was found to lead to the dura mater of the descending limb of the sigmoid sinus, and consequently this part of the sinus had to

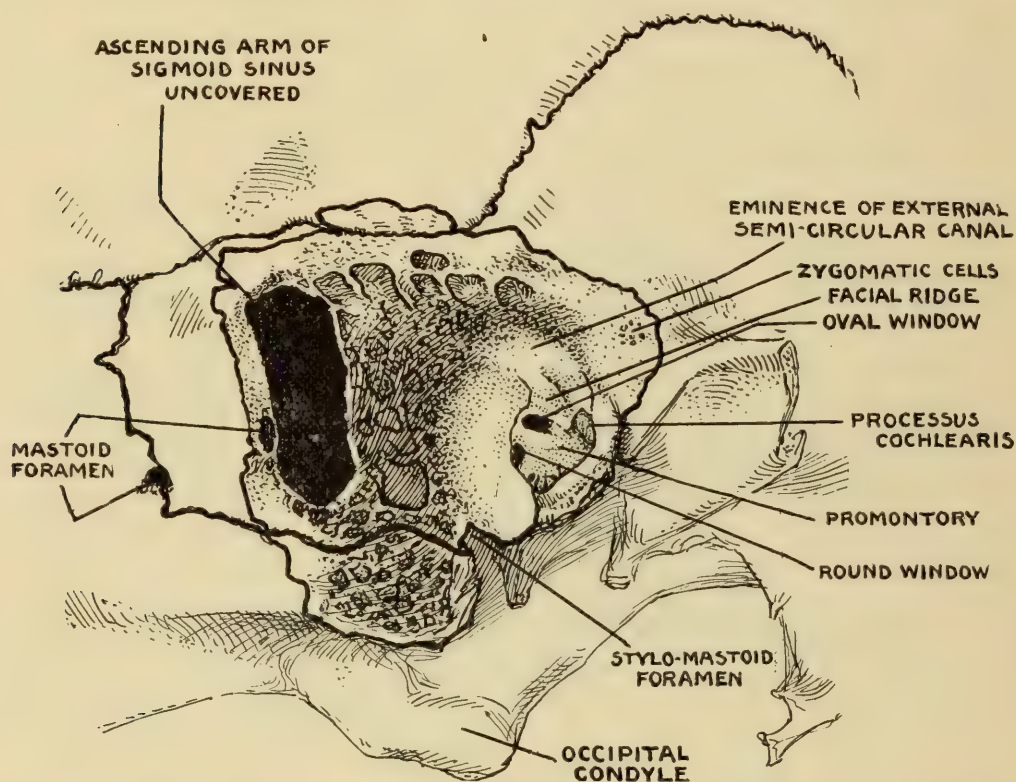


FIG. 219.—Same bone. After the performance of the radical mastoid operation. Shows the exposure of the descending limb of the sigmoid sinus.

be uncovered, revealing a pachymeningitis and an epidural abscess, which in this locality is an episinus abscess. The dura mater was further uncovered until a margin of healthy dura mater was exposed all around the diseased area.

The sinus felt hard and it was therefore decided to explore for sinus thrombosis. The sinus at both ends of the exposed area was compressed by pledgets of iodoform gauze, and the sinus incised longitudinally between them. A clot was found and removed. Loosening the gauze pledgets one at a time and quickly replacing

them allowed free bleeding in both directions. All the bone work shown in the figure was done with the rongeurs. A plastic flap (Fig. 223, A) was cut in the soft meatus. The ends of the compresses on the cut ends of the sinus were led out of the meatus. The mastoid incision was closed with a subcutaneous silkworm-gut suture. The wound was lightly packed through the meatus, care

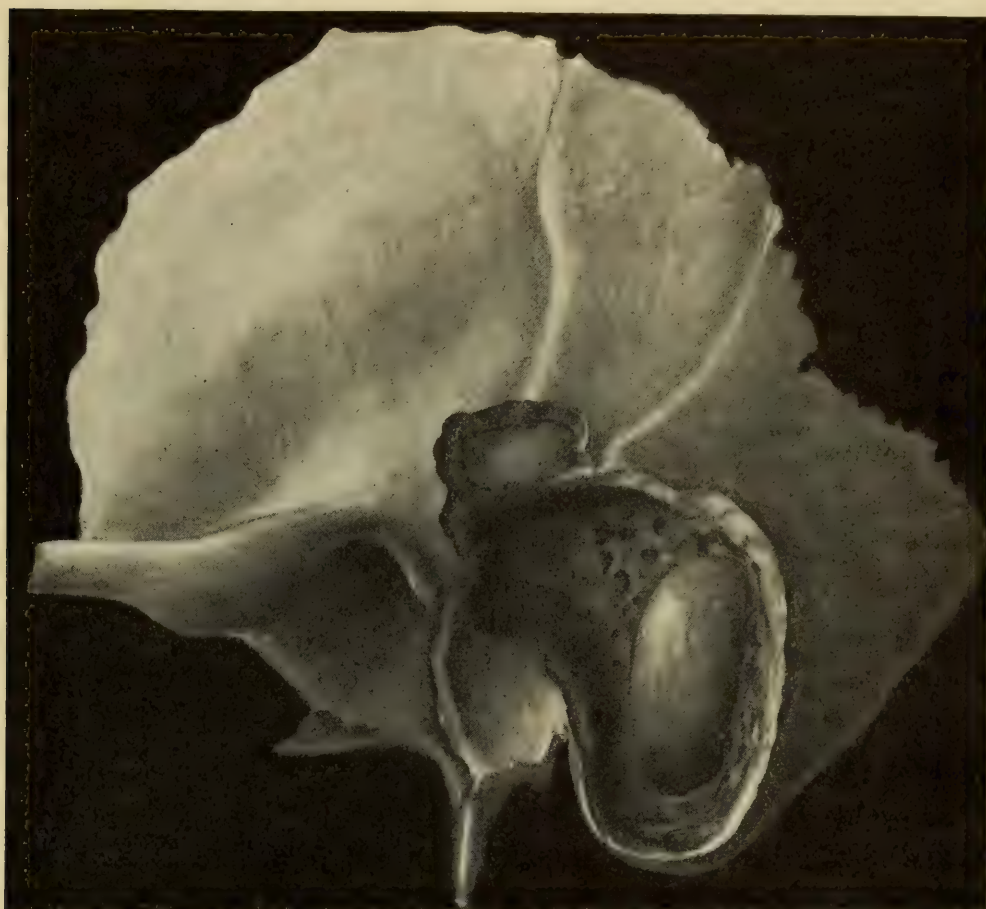


FIG. 220.—A diagram of a mastoid operation when the bone involvement required exposure of the sigmoid sinus or the middle fossa of the skull. (*Oppenheimer.*)

being taken to press the meatal flap up and back firmly. The usual dressings were applied.

Fig. 221 shows the same bone. Because of the diseased condition of the dura mater, a further extension of the exploration of the sinus, with exposure of part of the lateral sinus and horizontal limb of the sigmoid sinus and jugular bulb was demanded. Thrombosis was evident from the discoloration and hardness of the sinus wall. The exposure was extended backward until the healthy dura was

uncovered. Forward the exposure was continued to the jugular bulb. The uncovered sinus was blocked off at both ends with gauze pledgets and opened longitudinally with a knife. The clots were evacuated and when the gauze compress was loosened, bleeding was obtained from the posterior end of the incision. Since in this case no bleeding was obtained from the lower end, it was evident that the clot extended into the jugular bulb. It was thought wise, therefore, to expose, ligate, and remove the internal jugular vein. The diseased bone also led into the external semicircular canal and

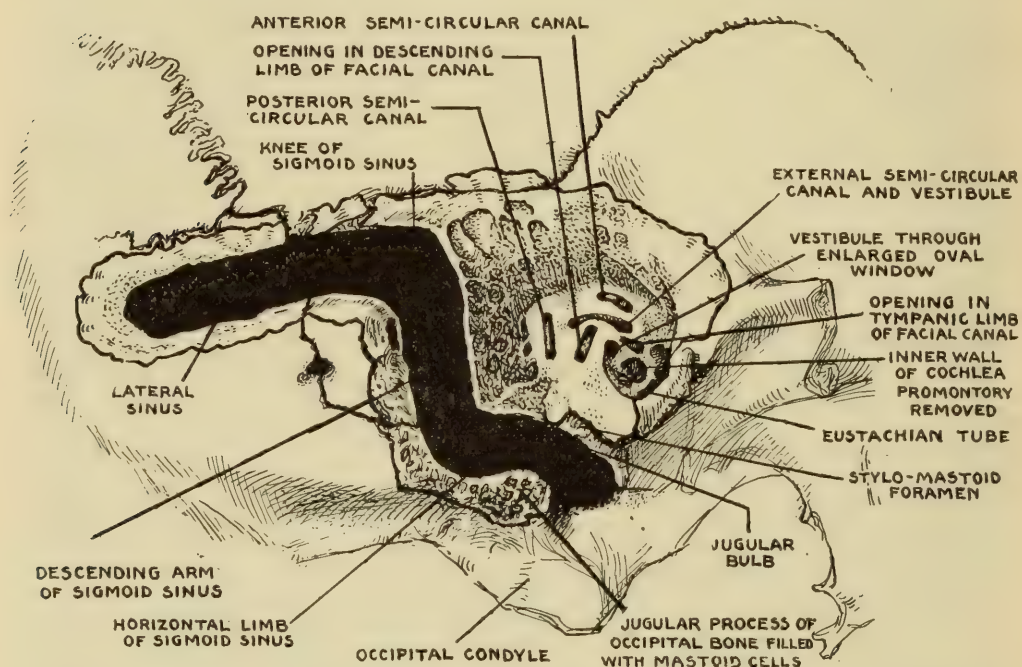


FIG. 221.—Same bone as Fig. 215. Radical mastoid operation has been performed, together with evacuation of the labyrinth, and exposure of the lateral and sigmoid sinuses and the jugular bulb.

internal ear. Consequently, the diagnosis of labyrinthine suppuration had to be made while the patient was on the table. The semicircular canals were opened by removing with scissor forceps the labyrinthine capsule that lay over the canals in the solid angle. The outer wall of the cochlea was also removed with the dental scrapers and scissor forceps (Fig. 229, No. 2). The vestibule was opened above the facial canal through the anterior part of the external semicircular canals. The oval window was enlarged below the facial canal. The lower whorl of the cochlea was opened, and the outer wall of the pyramid of the cochlea entirely scraped

away. The facial canal was accidentally opened at two points, but the nerve was in no way injured.

Fig. 222 shows the same bone in a case having symptoms of cerebral and cerebellar abscess. During the operation, the surgeon was compelled, in order to remove all the diseased bone, to uncover the dura mater of the cerebellar and middle cerebral fossæ. The dura mater showed evidence of pachymeningitis by its thickening and deep red color. A small sinus was found leading through the dura mater into the cerebellum and another into the temporo-

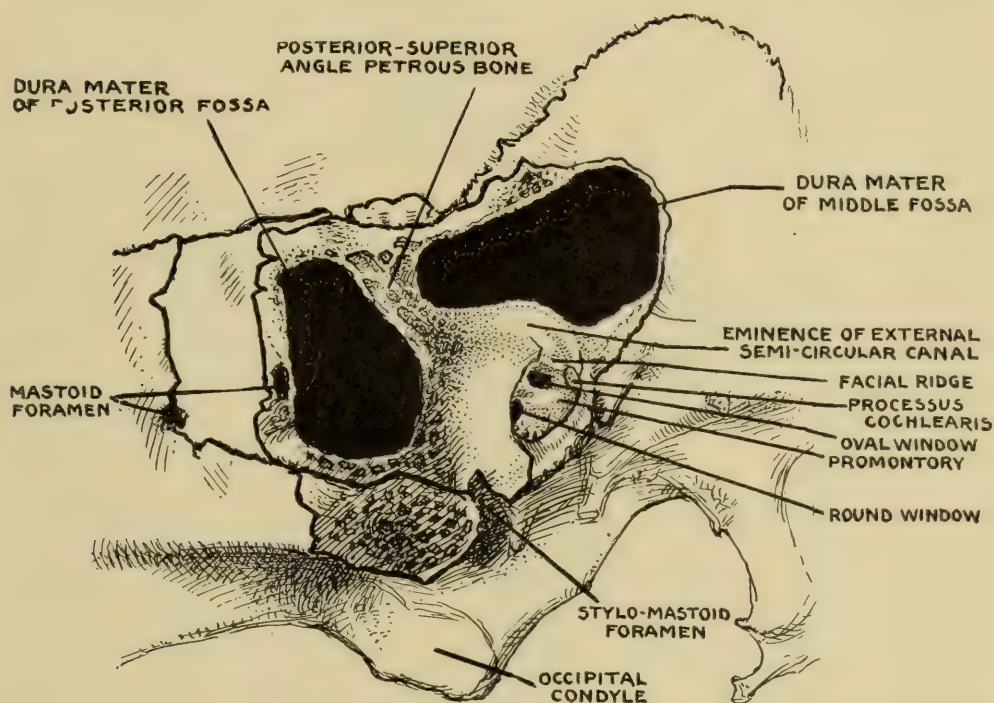


FIG. 222.—Same bone. Radical mastoid operation has been performed. Exposure of field of cerebral abscess and exposure of field of cerebellar abscess.

sphenoidal lobe. The bone about the sinuses was removed until healthy dura mater was uncovered in all directions. The dura mater was incised in both localities by an X-incision, which exposed the whole of the infected tracts in the temporo-sphenoidal lobe and cerebellum, and a large quantity of thick, green foul pus was excavated. The incisions were so broad that it was not necessary to insert drains in the brain wounds.

The completion of an operation in the temporal bone surgery requires that the osseous field of operation should be left with a smooth and even surface, bare of congested or necrotic bone.

The edges of the bone wound should be rounded off as smooth as possible to allow coaptation of the soft parts.

The membranous and cartilaginous meatus is slit according to the kind of operation that has been performed (see Fig. 223). When only part of the posterior osseous wall of the meatus has been removed, the cut B is made from the drum membrane along the posterior wall of the canal to the posterior lip of the external orifice. When the whole of the posterior osseous wall of the meatus has been removed, the cut A is made, forming a plastic flap to be pressed

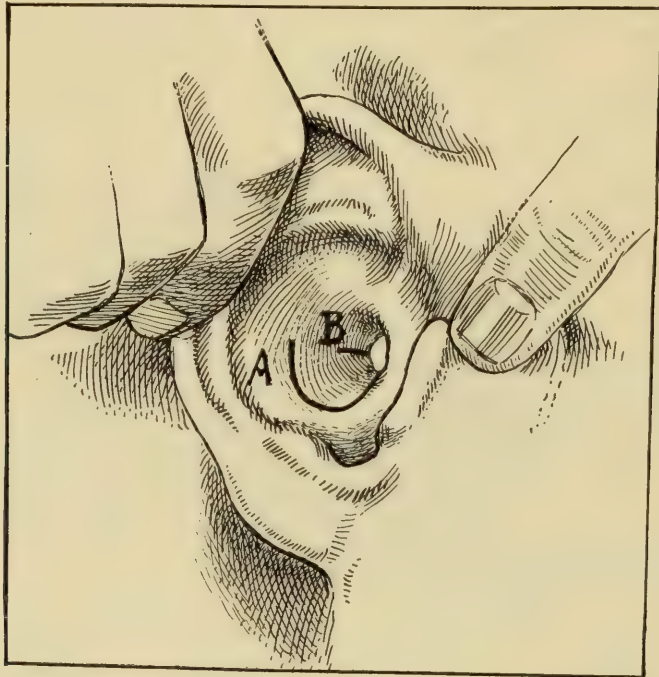


FIG. 223.—The right meatus stretched open; the curved line A indicates the line of incision for the plastic flap in the radical mastoid operation. The line runs along the floor of the canal to the concha, then turns backward and upward. The straight line B indicates the line of incision along the posterior wall of the canal, in the author's modified radical operation and in the author's complete mastoid operation.

up and back by the dressing. This cut is made along the entire length of the membranous and cartilaginous meatus, and upward through the anterior third of the concavity of the concha to a level opposite the upper wall of the meatus.

Closure of Wound.—Before closing, the wound should be thoroughly washed with isotonic salt solution. The question of drainage of the wound is determined by the condition in which the wound is left. If the wound is clean and smooth and without any inflamed tissues or tissues which have been contused by the operation, drainage

can with safety be reduced to a minimum. In these cases, the surgeon uses a small cigarette drain, half the diameter of a lead-pencil and made by a layer of rubber tissue and a layer of gauze rolled tightly. The drain is placed at the lower angle of the incision, extending to the deepest portion of the wound. If there are infected or contused tissues left in the wound, larger drainage in proportion to the area of these tissues is inserted. If extensive drainage is required the wound is packed with iodoform gauze, leaving sufficient room to remove the packing. The angles of the wound are sutured. When a radical operation has been performed, the drainage is provided through the enlarged meatus with gauze strips.

When practicable, a few deep, periosteal sutures are used, one midway in each limb of the wound. Chromicized catgut sutures are best. The skin is sutured by subcutaneous silkworm-gut sutures, metal clamp sutures, or interrupted sutures.

If a wound is to be closed around a small cigarette drain, it is desirable that when the wound is closed there should be blood enough to fill all the air spaces. If the wound is not oozing enough for this, blood can be made to flow by gently scraping the skin margin with a curette. After the wound is closed the meatus is gently packed with iodoform gauze strips.

Sufficient packing is used to slightly distend the flaps cut in the membranous and cartilaginous canal. After the radical operation the plastic meatal flap is pressed firmly backward by firm packing. Care should be exercised not to allow the packing to touch the drum membrane or the middle-ear contents, unless the radical operation has been done. A small doughnut of absorbent sterile gauze, wrung out in saline solution, is placed around the ear, and a small gauze handkerchief, also moistened, is placed over the ear. The whole is well covered with a piece of sterile rubber tissue. Over this is laid a large piece of sterile absorbent cotton and last a roller bandage, applied from below up and from the eye of the affected side toward the affected ear. This bandage presses the ear upward and backward into its normal position, supports the ear in this position, and holds the dressings in place.

Postoperative Treatment.—The special object of the treatment after operation is to continue drainage and to prevent infection. In order to minimize deformity or functional incapacity and to hasten repair, the plastic management of the wound requires constant

attention to asepsis and to all details. The dressings are changed the day following the operation. The packing in the meatus and the drain in the wound are not removed unless there are signs of infection of the canal. On the second day all the dressings, both packing and drain, are removed. The canal is filled with boric acid powder and the wet dressing again applied. On the third and



FIG. 224.—Shows mastoid bandage applied. It passes wholly above the sound ear. (*Whiting.*)

subsequent days, the wound is dressed in the same way until the discharge ceases and the redness of the wound has disappeared. When these have ceased, boric acid is dusted upon the wound and a dry dressing applied until healing is complete. At each subsequent dressing, the meatus is wiped out with sterile cotton applications and sterile boric acid powder insufflated. The skin sutures are removed between the second and fourth days. Inflation of the

middle ear is practised from the first, either by Valsalva's method or by Politzeration. Catheterization should not be used until the patient is well along in convalescence.

The Technic of the Management of Infected Operative Wounds.—Various methods of cleansing infected wounds are to be tried until the one most satisfactory in the individual case has been determined. It is best to begin in the sthenic cases with the aluminum wash

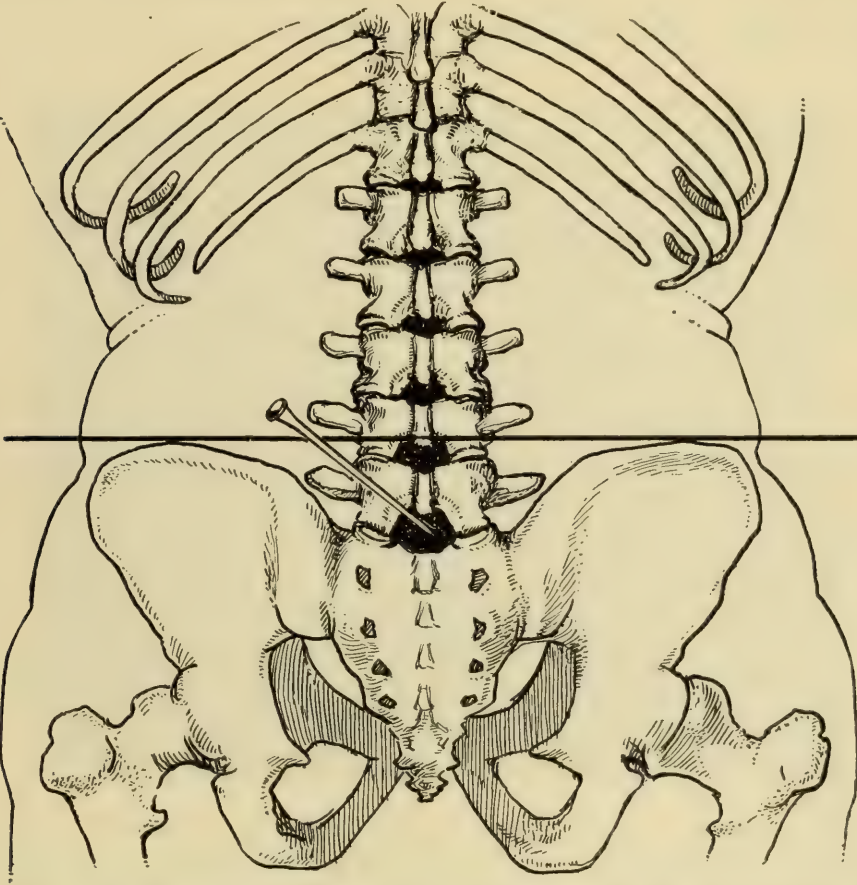


FIG. 225.—Lumbar Puncture. Diagram showing the lumbar intervertebral spaces, and the position of the canula in lumbar puncture. The line connecting the crests of the ilia passes above the last lumbar spine. The largest intervertebral space is the one below this spine.

No. 12 and in the asthenic cases with the red zinc sulphate wash No. 10. Other dressings to be used are painting with tincture of iodine, alcohol 50 per cent., creoline poultice 1 to 1000, corrosive sublimate poultice 1 to 5000, and carbolic acid poultice, 1 to 40. If a wound, which has been packed, does not granulate sufficiently rapidly, it can be stimulated with the red wash poultice and with balsam of Peru application, or with tincture of iodine.

Lumbar Puncture.—The lower lumbar region is carefully sterilized with Harrington's solution (No. 8). A strong hollow needle three inches long is selected and carefully sterilized. The patient is made to bend the back forward in order to open the inter-vertebral spaces. A convenient method is to have the patient sit on the edge of the bed, and rest his elbows on his knees. Fig. 110 shows that the inter-vertebral space between the sacrum and the last lumbar vertebra is the widest. This space is the second intervertebral space that lies below a line drawn across the tops of the crests of the ilia. The

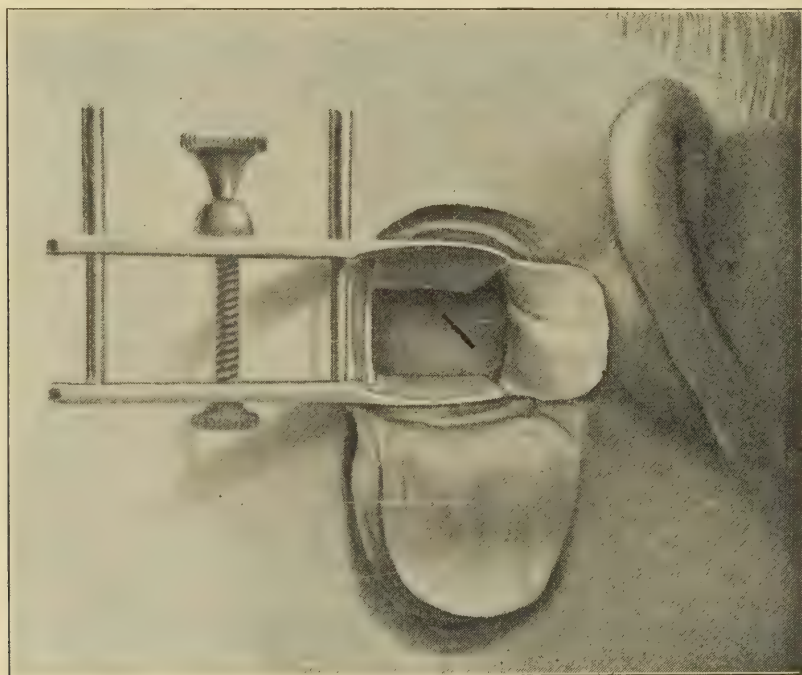


FIG. 226.—Second Stage of the Auditory Nerve Resection Operation. The figure shows the tentorium and upper surface of the petrous pyramid exposed, and incision in the tentorium parallel to the posterior superior edge of the petrous pyramid.

spinous process of the last lumbar vertebra lies below the cross line and just below this lies the largest intervertebral space. The needle is plunged in at right angles to the surface, about one-eighth of an inch from the median line. The distance the needle has to go inward in order to pierce the dura mater varies with the age, size, and muscular development of the patient. The flow of fluid is spontaneous when the dura mater is pierced. The needle, if properly directed, will not meet a solid obstruction until it touches the anterior wall of the spinal canal. If the field of the needle indicates that it has entered and traversed the spinal canal and

reached the anterior wall without the appearance of any fluid, the needle is probably occluded. It should be withdrawn cleaned and reinserted. If there is only a gentle trickle of fluid, 20 c.c. may be withdrawn; if there is evidence of extreme tension the fluid spurts out briskly. In this case enough fluid should be withdrawn to reduce the tension to normal. When the amount of fluid desired has been drawn off the needle is withdrawn and a small sterile dressing applied.

Surgery of the Auditory Nerve.—A method of resection of the

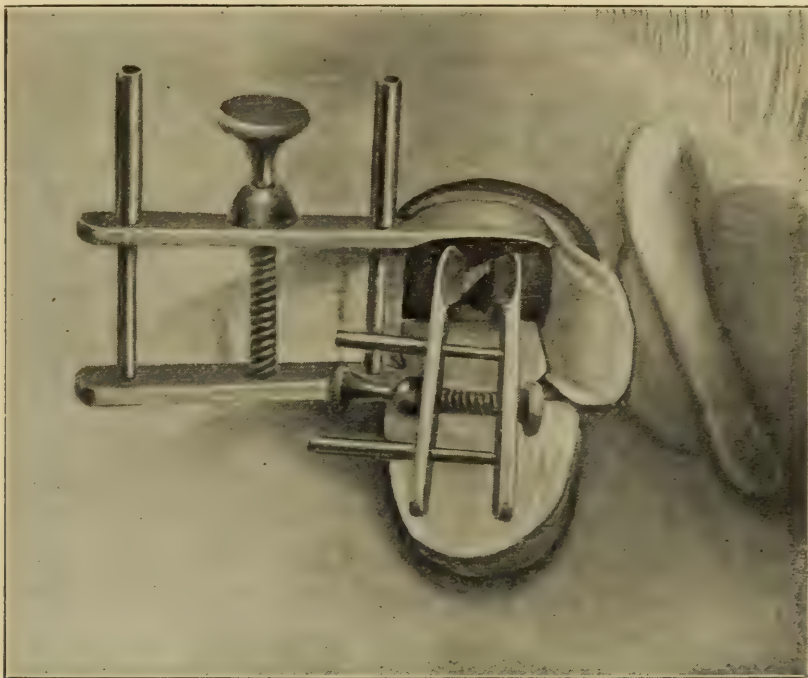


FIG. 227.—Third Stage of the Resection of the Auditory Nerve. The auditory nerve is seen at the bottom of the incision in the tentorium.

auditory nerve for grave tinnitus is through an operative field extending from behind the auditory meatus on a level with the tentorium inward along the posterior edge of the petrous pyramid through the tentorium near its attachment directly to the orifice of the internal auditory meatus, where the auditory nerve is revealed as a bright white cord nearer the surgeon than the facial nerve. The auditory nerve should be grasped with forceps and avulsed or it can be severed with sharp hook or scissors. This operation is to be used as a last resort, when the patient has an unendurable tinnitus.

Surgical removal of the Gasserian ganglion, its branches and

roots, can be done through the otological opening which is used to expose a temporal lobe abscess—the dura mater is elevated, the brain tissue compressed, the apex of the anterior surface of the petrous bone exposed, and the ganglion and its branches removed.

Facial Paralysis.—In recent cases of traumatic facial paralysis the injured ends of the nerve can be dissected out and sutured. The prognosis is good for a satisfactory result if sufficient slack be found to allow the ends to be united. In traumatic facial paralysis of long standing direct repair of the nerve is usually impossible. In these cases if the facial nerve can be found it can be anastomosed with the hypoglossal with the expectation of a partially satisfactory result.

Operation for Decompression of the Brain.—The otological operations for intracranial tension are performed by extending the field of a mastoid operation so that the cerebral or cerebellar dura mater will be exposed (see Fig. 69). Incision of the exposed dura will drain the arachnoid space. Puncture of the lateral ventricle will drain the ventricular system.

MINOR AURAL SURGERY.

Minor aural surgery is directed to the drainage and excision of infected areas, to drainage of othematoma and removal of benign tumors, to the correction of deformities, cicatricial contractions and adhesions, repair of wounds, and to local depletion. The external skin and meatus are sterilized in the same way as for major operations.

Before attempting cosmetic surgery of the auricular deformities, a cast of the ear should be taken, the size of the piece of cartilage to be removed noted on the cast, the site selected and measured and the operation carefully planned. At the time of operation the cast should be used to direct the minutiae of the operation.

Deformities of the pinna, due to superabundant cartilage, are corrected by lifting the skin on the posterior side of the cartilage to be removed and taking out the cartilage, together with its perichondrium. The incision should be made in the hollow of a fold of the auricle, and should always be on the posterior side. If the cartilage to be removed lies along the border of the concha, the operation consists merely in the removal of enough of the edge of

the cartilage to reduce the pinna to the desired size. When the bleeding has ceased, the skin is carefully sutured with fine horse-hair sutures and a collodion dressing applied. The dressing consists of a strip of gauze folded over on both sides of the operative field, and coated with flexible collodion. This operation is selected when the upper and posterior borders of the pinna are too large.

If the superabundant cartilage lies toward the center, as well as at the periphery of the pinna, a wedge-shaped piece with the base at the periphery is removed. Enough cartilage should be removed to make the auricle of proper size and shape. All bleeding is stopped and the cut edges of the cartilage are carefully adjusted and held in place by perichondrial sutures of fine catgut. The skin flaps are treated as in the previous operation. This operation is for cases where the whole concha is too large.

When the concha is too small at the periphery of the pinna, causing the ear to be cup-shaped, a lenticular strip of cartilage can be removed from the concha enough to contract the concha and to restore the ear to a normal appearance. The wound and suture are arranged as in the previous operation.

When the deformity of the auricle is caused by undue prominence, or to misshapen folds of the pinna or concha, the defects are corrected by uncovering the perichondrium over the seat of the concavity of the desired fold, and by passing fine silk sutures through the perichondrium at two points which are placed on the edges of the desired fold and drawing them together to form the fold. Several sutures should be used in order to divide the strain and to prevent pulling out. After this cosmetic operation, a retention dressing must be put on with a roller bandage, and later a bandage or cap must be continually worn for two or three months.

When the pinna stands out at right angles, the skin of the posterior auricular fold is incised longitudinally, the skin loosened in both directions, and the perichondrium of the concha firmly sutured with silk to the mastoid periosteum in order to decrease the post-aural angle sufficiently to place the auricle in the desired position. In suturing the periosteum, as many sutures as possible should be used in order to equalize the strain. A retention dressing, as in the preceding operation, is required.

Othematomata are treated by subcutaneous aspiration with a fine needle and firm compression between tin disks, padded with

cotton. The disks are held in position by elastic bands wound around the wires prepared for the purpose.

Subperichondrial abscess is treated by multiple free incision and by wet dressing of acetate of aluminum wash No. 12, page 592.

Excision of Branchial Cysts and Fistulæ. (Fig. 1).—Owing to the small size of these capillary fistulous tubes it is necessary to inject them with some colored fluid before operating on them, as otherwise it is impossible to follow their course. A good injection medium is cocoa-butter and Prussian blue, warmed and injected with a middle-ear syringe and canula (Fig. 229, No. 18). The dissection must be made with care in order to avoid injuring branches

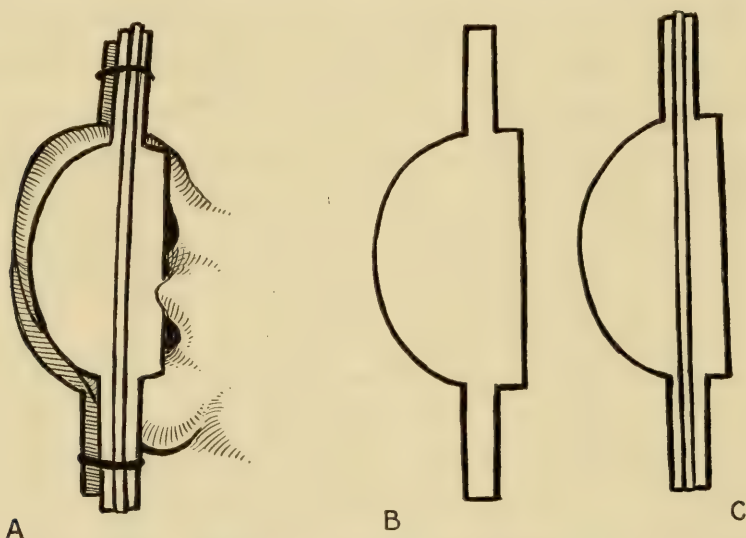


FIG. 228.—A shows the compression splint for othematomata in place on the auricle. The splint is held in place and compressed by rubber bands. B shows inner side of one of the tin splints. C shows outer surface of one of the tin splints with strengthening wire which is soldered on.

of the facial nerve. The entire fistulous tract should be dissected out. This may require deep dissection in the neighborhood of the ear and the articulation of the jaw. The wound is closed around a cigarette drain and managed in the same way as a mastoid wound.

Foreign bodies impacted in the meatus sometimes require operative assistance for their removal. The skin in the postauricular fold is cut, the posterior attachment of the cartilaginous canal to the bony canal loosened, and the auricle displaced forward, thus exposing the osseous canal from behind. The foreign body can then be removed. The auricle is replaced and carefully sutured to the periosteum of the mastoid with chromicized catgut. The skin wound should be closed by subcutaneous sutures of silkworm

gut. The meatus is lightly packed with formalin gauze, and a gauze handkerchief followed by roller bandage completes the dressing. Care must be exercised that the ear does not droop. To prevent this, a cap should be worn for from six to eight weeks.

Removal of Exostoses of the Canal.—The pedunculated exostoses may be broken loose with a blow from a blunt instrument, such as the handle of a dental scraper. The growth—unless it is extremely large and impacted—is readily removed by the method used in the removal of a foreign body. If the growth is impacted in the canal, the canal must be opened behind the auricle and the exostosis removed like an impacted foreign body. The sessile, deep-seated exostoses may require enlargement of the canal before they can be curetted away. The same technic is used as in the radical mastoid operation, except that only the anterior periosteal flap is lifted, and the mastoid cells are not opened. Only a part of the posterior wall of the canal is removed—enough to allow access to the bony growth and to facilitate its removal. The periosteum of the canal is raised as carefully as possible; after the exostosis has been scraped away with a sharp curette the membranous canal wall is slit longitudinally. The posterior aural wound is closed with a peritoneal suture of chromicized catgut, and the skin flaps are united by subcutaneous sutures of silkworm gut. The meatus is lightly packed with formalin gauze.

Stricture of the External Auditory Canal.—Annular strictures are treated by multiple incisions and packing. The packing should remain in for forty-eight hours. When there is extensive atresia of the canal, the same technic is followed as described for deep exostosis of the canal. It is an adaptation of the technic for the radical mastoid operation.

Furuncles and abscess of the canal are treated by wide and deep incision through the infected area to the cartilage. If the abscess has extended and passed beyond the limits of the cartilaginous meatus, a wide incision through the cartilage down to the periosteum is required, and sometimes a counteropening through the skin adjacent to the auricle, over the point of swelling. When an anterior incision is made, care must be taken not to injure the capsule of the mandibular articulation or branches of the facial nerve. The wound is wiped with pure carbolic acid, then with alcohol, and both the wound and the meatus are packed with iodoform gauze.

If an external wound has been made it is closed and drainage is made through the canal.

Post-aural fistulæ leading into the mastoid antrum, sometimes occur after spontaneous or operative drainage of the mastoid antrum. If they are not healed, they require a complete mastoid operation; if healed, a plastic operation is required to allow the skin flaps to be united properly. For this purpose it is best to resect the skin freely and to remove all the bone that hinders the approximation of the skin flaps and the obliteration of the sinus cavity. A free opening into the membranous meatus should be made for drainage, and the posterior wound closed with subcutaneous sutures.

OPERATION ON THE TYMPANIC MEMBRANE: MYRINGOTOMY.

Following the cuts shown in the diagram, Fig. 211, No. 1, the membrane is incised with the myringotome (Fig. 229, No. 9). The patient's head must be kept steady to allow deliberate incision. Local or general anesthesia is usually required. For local anesthesia use solution No. 3. The most convenient general anesthetic to give is ethyl chloride.

Ossiculectomy.—In order to allow drainage in chronic middle-ear suppuration, it is occasionally thought wise to remove the major ossicles. Local anesthesia is necessary for ossiculectomy. After the ear has been syringed out with alcohol followed by sterile water, a 20 per cent. solution of cocaine in 1-1000 adrenalin, is instilled into the middle ear. The ear is plugged with cotton. The cocaine is left in from ten to twenty minutes. If the cocaine passes into the pharynx, care must be exercised that poisoning does not result. When anesthesia is complete, the meatus and middle ear are wiped dry, and the remnants of the drum membrane are incised close to and parallel to the handle of the hammer. The small ring knife (Fig. 229, No. 5) is passed over the handle of the hammer, and pressed upward cutting the ligaments and tendon of the hammer, and the hammer drawn out in the ring. With a small-angle knife (Fig. 229, No. 8) the incus is separated from the stapes. Then with the incus hook (Fig. 229, No. 10) placed carefully over and behind the incus, forward rotation will bring the incus out into view and it can be removed with the alligator forceps (Fig. 229, No. 3).

Subsequent treatment is the same as for suppurating cases. No packing is necessary.

Removal of polypi and granulations can be done under direct observation with the alligator forceps (Fig. 229, No. 3). Local anesthesia is usually necessary. Care must be taken not to dislocate the ossicles or remove tympanic structures.

Exploratory tympanectomy is employed for intratympanic examination for adhesions. With the myringotome (Fig. 229, No. 9), a triangular flap is cut in the posterior-superior quadrant of the membrane, its base being downward. This exposes the stapes and the tip of the long process of the incus and promontory. Inspection with a magnifying lens will reveal any adhesions in the neighborhood. When the inspection is complete the flap is gently pressed back into position, and the canal closed with a little absorbent cotton. The ear should be inspected every day until the union of the flap has obliterated the perforation.

The operative treatment of tension anomalies requires intratympanic severing of the adhesions of the drum membrane and ossicles with the angle knife (Fig. 229, No. 8). The same incision is used as has just been described.

For local depletion, wet cupping is sometimes used. It is to be applied over the mastoid antrum or over the mastoid foramen for mastoid and tympanic inflammations. For inflammations of the canal, cupping in front of the tragus will give relief. The skin is incised with a sharp knife or artificial leech, and suction applied with a hot bottle with suction bulb or air pump.

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CHAPTER XXXVII.

THERAPEUTICS OF THE EAR.

GENERAL THERAPEUTICS.

General therapeutics of the ear include the remedies which have a special selective action on the ear, and those which, through their influence on the general system, have a favorable effect upon the ear. For alleviating inflammatory conditions in the ear, we use, besides rest in bed and light diet, magnesium sulphate as a laxative, potable water, saline high enemata, antitoxins, vaccines, epidermoclysis, venous infusion of isotonic salt solution, and transfusion. In asthenic cases of functional disturbances, when the circulation, nervous and muscular systems are at fault, we use general tonic treatment, with especial attention to the circulation, digestion, and bowels. Strychnia in moderate doses is a powerful auditory stimulant. In the sthenic cases, with local congestion, we use depleting treatment with emetics, diaphoretics, such as pilocarpin, tartar emetic, and various purgatives. Quinine in doses from 2 to 3 grains daily is often useful in cases of labyrinthine congestion with vertiginous symptoms. Syphilitic and tuberculous infections demand the well-known methods of treating the general system under these conditions.

SPECIAL LOCAL THERAPEUTICS.

SOLUTIONS.

I. MILD ANTISEPTIC.

Saturated Solution of Boric Acid in Water.—A mild antiseptic solution which should be sterilized by boiling. This solution is used for syringing in subacute and chronic purulent cases when the discharge is abundant. It also serves as a vehicle for the therapeutic use of heat in acute tympanic inflammations. For this purpose the solution is used as a douche in a fountain syringe

placed at very slight elevation, or it is dropped directly into the ear from a medicine dropper. The solution should be used as hot as can be borne, up to 100° – 110° F.

2. HYGROSCOPIC ANTISEPTICS.

a. Saturated Solution of Boric Acid in Absolute Alcohol.—The best antiseptic astringent solution for use in the middle ear in subacute and chronic suppuration. A few cases will not tolerate it, and in a slightly larger number of cases it is inefficient. The solution is applied to the ear with a dropper after the ear has been wiped dry. It is ineffective when used after syringing.

b. Saturated Solution of Iodoform in Absolute Alcohol.—A stimulating antiseptic solution, useful in some of the cases where solution *a* is ineffective. It is helpful in syphilitic ulcerative conditions.

c. Commercial Alcohol.—Its chief use is as a destroying agent of the spores and mycelium of the aspergilli. It is used as a syringe solution or can be dropped into the canal with a medicine dropper.

d. Absolute Alcohol.—An antiseptic hygroscopic solution for the middle ear. Leaves no residue.

3. ASTRINGENT ANTISEPTICS.

a. One-half of 1 per cent. to 1 per cent. Solution of Nitrate of Silver.—Strong astringent antiseptic stimulating solutions for application in the tympanic cavity or for use in the middle-ear syringe.

b. Two per cent. Solution of Nitrate of Silver.—A more stimulating solution than *a*.

c. Ten per cent. Solution of Argyrol.—A non-irritating silver antiseptic solution for use in the tympanum.

d. Twenty-five per cent. Solution of Argyrol.—A slightly irritating silver antiseptic solution for use in the middle ear.

e. Fifty per cent. Solution of Argyrol.—A non-irritating silver antiseptic for use in the canal.

4. STRONG ANTISEPTICS.

a. Corrosive Sublimate, 1-1000 Solution.—A good antiseptic solution for external use and for use in the canal in otitis externa circumscripta.

b. Corrosive Sublimate, 1-5000.—A good solution for use in the tympanum and as an antiseptic douche in syphilitic cases and a few of the cases where solution *a* is ineffective.

c. Solution of Carbolic Acid in Water, 5 per cent.—A useful antiseptic

anesthetic application for the canal. Can be used as drops in otitis externa.

d. Solution of Carbolic Acid in Water, 2 1/2 per cent. Solution.—A good antiseptic syringing solution for purulent otitis.

5. ASTRINGENT CORROSIVE ANTISEPTICS.

a. Ten per cent. Chromic Acid Solution in Water.—A mild antiseptic astringent escharotic for the middle ear.

b. Ten per cent. Solution of Nitrate of Silver.—Slightly escharotic to the middle ear and very stimulating.

c. One Hundred per cent. Solution of Nitrate of Silver.—A stimulating escharotic for the middle ear.

6. ANESTHETIC ANTISEPTIC.

Solution of Carbolic Acid in Glycerine, 10 per cent. Strength.—An antiseptic and local anesthetic in otitis externa circumscripta. To be used on cotton pledgets or as an application to the canal.

7. ANTISEPTIC DIGESTANT.

Peroxide of Hydrogen.—An active antiseptic for the middle ear with the power of disintegrating and sterilizing accumulated detritus. It is an irritant. Its chief use is for rapid sterilization and disintegration of foul collections in the tympanum.

8. EXTERNAL ANTISEPTIC FOR STERILIZING THE OPERATIVE FIELD.

Harrington's Solution:

Commercial alcohol.....	640.0
Hydrochloric acid.....	60.0
Water.....	300.0
Corrosive sublimate.....	0.8

This solution is used as a means of sterilizing the operative field. Three minutes' exposure of the skin to the solution is sufficient for satisfactory sterilization. The solution should be washed off with sterile water.

9. ALKALINE SOLUTION.

Saturated Solution of Bicarbonate of Soda in Water.—Dropped with medicine dropper into the meatus to soften horny masses, and as a syringe solution for the middle ear to soften epithelium and cholesteomata. It is used with the large syringe or with the middle-ear syringe.

10. WOUND DRESSINGS, STIMULATING ANTISEPTICS.

a. Tincture of Iodine.—A powerful stimulant and antiseptic. A stimulating application to sluggish infected wounds. Especially useful for destroying maggots in the ear.

b. Red Wash:

Zinc sulphate	gr.viii
Spt. lavender comp.....	℥iii
Aq.....	ad. ℥iv

An antiseptic astringent stimulating wash to be used as a wet dressing on indolent infected wounds.

11. WOUND DRESSINGS; STIMULATING SOLUTIONS.

a. Balsam of Peru.—A strong stimulant for sluggish wounds. Should be brushed on the wound.

b. Balsam of Peru in Oil Solution:

Balsam of Peru	℥iii
Castor Oil	℥xiii

A stimulating dressing for wounds. It is to be packed in the wound or applied on a gauze strip.

c. Tincture of Benzoin.—A stimulating application for sluggish purulent ears.

d. Compound Tincture of Benzoin.—A less stimulating application than *c*.

12. WOUND DRESSING; SEDATIVE ANTISEPTIC.

Aluminum Wash:

Acet. aluminum	5
Acet. lead.....	25
Water	500

Shake well and dilute 1 to 4 for use.

An astringent wash for wet dressing of infected wounds.

13. MIDDLE-EAR STIMULANTS FOR USE IN TROPHOPATHIA TYMPANICA.

a. Glycerine Solution:

Glycerine.....	℥i
Acid carbolic	
Iodine	āā gr.iii

For use in the middle ear as a stimulant in trophopathia tympanica. Two to three minims are blown into the tympanum through the Eustachian catheter.

b. Benzoinol Solution:

Acid carbolic	
Iodine	āā gr.ii
Benzoinol	3i

For use in the middle ear as a stimulant in trophopathia tympanica. Two to three minims are blown into the tympanum through the Eustachian catheter.

14. RUBEFACIENTS.

Cantharidin Solution:

Cantharidin	1.00
Oil	100.00

This solution is a rubefacient for use in the canal in trophopathia tympanica, and on the mastoid process.

15. DILUENTS; WOUND CLEANSERS.

a. Normal Salt Solution:

Sodium chloride	8.00
Water	1000.00

This solution is used by the mouth and as a high enema in bacterial toxemia to assist elimination of the toxins.

b. Isotonic Salt Solution.

NaCl	0.59
KCl	0.04
CaCl	0.04
MgCl	0.025
NaH ₂ PO ₄	0.0126
NaHCO ₃	0.351
Glucose	0.15
Water	1000.00

This solution is used for washing and moistening wounds.

16. HEMOSTATICS.

a. Adrenalin, 1-1000 Solution.—For use in clearing blood from operative fields.

b. Adrenalin, 1-5000 Solution.—For use with cocaine as a local anesthetic in middle-ear operating.

17. COLLODION SOLUTIONS.

a. Contractile Collodion.—An application for the support of relaxed drum membranes. It is to be painted on the relaxed area of the drum membrane with a fine cotton applicator.

b. Flexible Collodion.—Useful for fastening small dressings on wounds.

POWDERS.

1. *Boric Acid.*—The best antiseptic dusting powder for use in the middle ear and wounds.
2. *Iodoform.*—A stimulating dusting powder for use in the middle ear and wounds.
3. *Aristol.*—A drying powder for use on convalescent wounds.
4. *Pyoktanin Blue and Boric Acid, Equal Parts.*—An antiseptic dusting powder for use in otitis media tuberculosa.
5. *Acetanilide.*—An antiseptic dusting powder.
6. *Calomel.*—A dusting powder for use on luetic lesions.
7. *Xeoform.*—A drying powder for use in the middle ear.
8. *Talcum.*—A drying powder for use on healing wounds.

ESCHAROTICS.

1. *Fused Bead of Nitrate of Silver.*—A stimulating powerful escharotic for use in the middle ear and on granulating wounds.
2. *Fused Bead of Chromic Acid.*—A less stimulating escharotic for use in the middle ear.
3. *Perchloride of Iron, Supersaturated Solution.*—An astringent escharotic for use in the middle ear.
4. *Carbolic Acid Crystals.*—An anesthetic escharotic for use in the middle ear.
5. *One per cent. Solution of Corrosive Sublimate in Water.*—An escharotic and stimulating antiseptic, useful in sluggish chronic purulent otitis and as an application for stimulating purposes.

UNGUENTS.

1. *Lanolin.*—Used as an emollient for the skin of the canal. It should be applied lightly with a cotton carrier.
2. *Lanolin \mathfrak{Z} i and Creolin \mathfrak{Z} iii.*—An antiseptic anesthetic emollient for the canal. Apply lightly with cotton carrier.

3. *Lassar's Paste*:

Acid salycilate	gr. xv
Starch	
Zinc oxide	āā 3ii
Vaseline	3iv

To be spread on gauze and used for eczema of the auricle and surrounding skin.

LOCAL ANESTHETICS.

1. *Cocaine 20 per cent. Water Solution*.—For use in the tympanum.

2. *Camphophenique*.—For use in the canal in otitis externa.

3. *Bonain Mixture*:

Cocaine	
Menthol	
Carbolic acid	āā

Add supernephrin before using 1/4.

The best local anesthetic for operations on the skin and for otitis externa.

4. *Alopin 20 per cent. Solution*.—For use in the tympanum when cocaine is contraindicated.

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CHAPTER XXXVIII.

SPECIAL INSTRUMENTS, PROCEDURES, AND APPLIANCES.

INSTRUMENTS.

SPECIAL OTOLOGICAL INSTRUMENTS.

1. Rongeurs: For removing all the mastoid bone in any mastoid operation, except a part of a sclerosed bone, or the final clearing up of a bone.

2. Scissor Forceps: For breaking down portions of the labyrinthine capsule and to nip off the outer wall of the cochlea and promontory. These forceps are also used to break away the annulus tympanicus in the radical operation.

3. Hartman's Alligator Forceps: For removing polypi, the malleus, incus, small sequestra, and any foreign bodies which it can grasp.

4. Eustachian Catheters, malleable, silver, 3 sizes. The curves of these catheters are easily altered to suit the individual case. Hard-rubber catheters have some advantages over metal catheters, but they are disadvantageous because of the difficulty of sterilizing the rubber.

5. (a) Two ring curettes, small and medium, with malleable handles; (b) small ring knife.

(a) Ring curettes: For removing foreign bodies and cerumen from the canal.

(b) Small ring knife: For disarticulating and removing the hammer in ossicectomy.

6. Small Hook: For removing foreign bodies.

7. (a) Small Triangular Scraper: For the gross removal of the labyrinthine capsule which covers the external semicircular canal, the solid angle and the promontory.

(b) Flat scraper: For the fine removal of the labyrinthine capsule.

(c) Pointed right-hand and left-hand scrapers: For enlarging an opening into the labyrinth through a semicircular canal, oval, or round window.

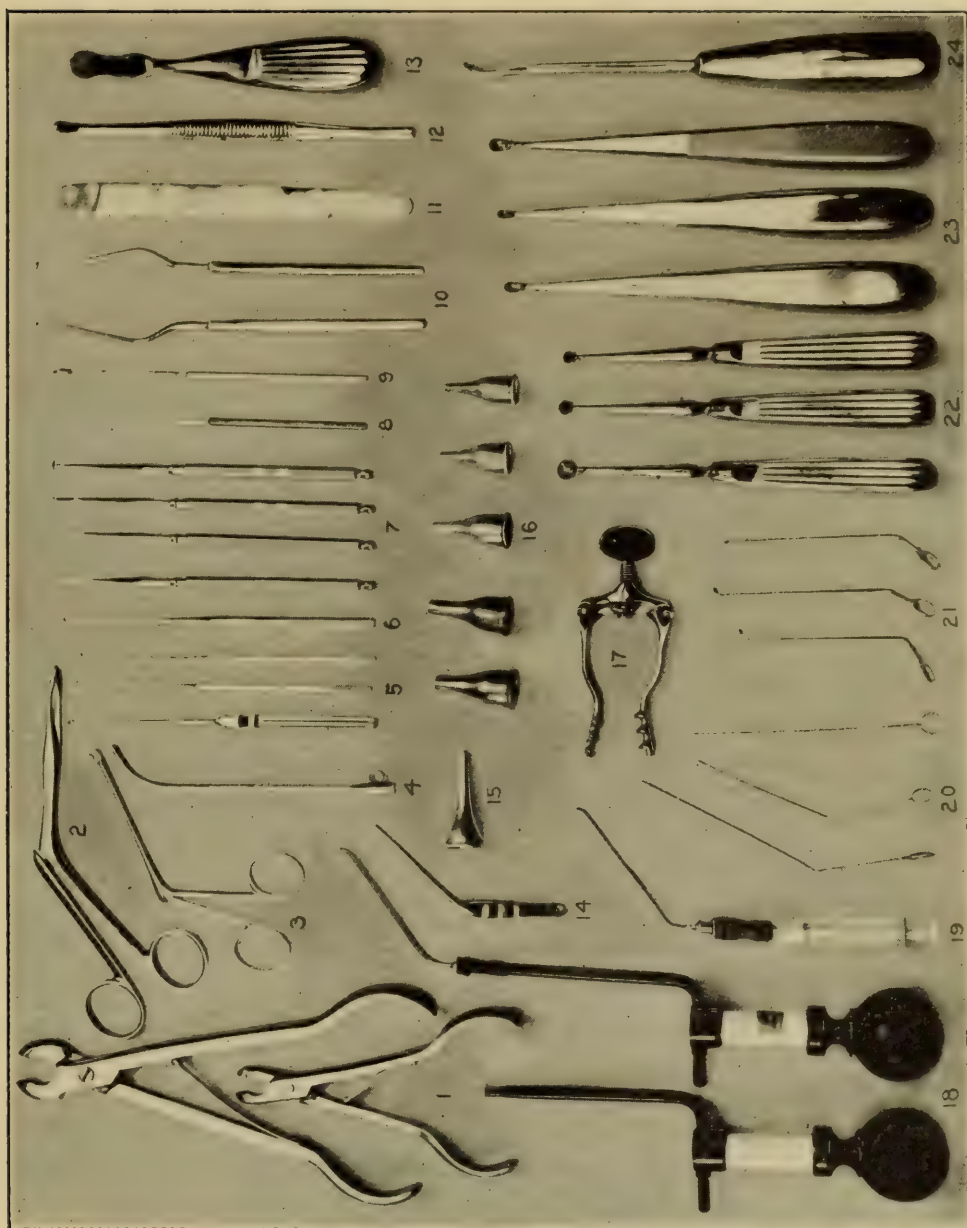


FIG. 229.—1. Rongeurs, large and small. 2. Scissor forceps; 3. Alligator forceps (Hartman), small. 4. Eustachian catheters, malleable silver, three sizes. 5. Two ring curettes, small and medium, with malleable handles; small ring knife. 6. Small hook for removing foreign bodies. 7. Instruments for labyrinthine excavation—on the right, small triangular scraper; on the left, flat scraper; center, two pointed right and left scrapers. 8. Small middle-ear angular tenotome (Buck), malleable handle. 9. Myringotome. 10. Two incus hooks, right and left (Sprague). 11. Malleable spatula retractor, five-eighths inch wide. 12. Dura mater elevator. 13. Periosteum elevator. 14. Fine-angle forceps (Blake). 15. Long-shafted aural speculum. 16. Aural specula, assorted sizes (Gruber's). 17. Mastoid wound retractor (Jansen). 18. On the right, middle-ear canula for powder, 2 powder blowers (Davidson). 19. Middle-ear syringe and canula (Blake). 20. On the left, No. 7, piano-wire cotton applicators for meatus (Blake); center instrument, middle-ear probe (Blake); on the right, instrument, middle-ear cotton applicator (Blake). 21. Three assorted middle-ear curettes (Blake), malleable, one straight, two different lengths of bend. 22. Three assorted curettes (Richards). 23. Three assorted curettes (Blake). 24. Front bent gouge.

8. Small Middle-ear Angular Tenotome (Buck), Malleable Handle: For middle-ear tenotomy and for cutting adhesions.

9. Myringotome; a small pointed knife with a straight cutting edge: For incising the drum membrane and the wall of the inner end of the canal; also for cutting the stapedius tendon.

10. Incus Hooks, Right and Left (Sprague): For bringing down the incus in ossicectomy. This hook is used when the alligator forceps cannot hold the incus or when the incus has been displaced up and back.

11. Malleable Spatula Retractor: For meningeal retraction.

12. Dura Mater Elevator: For separating the dura mater from the bone before cutting the bone with a rongeur. This separation prevents tearing the dura mater while the fragment of bone is being cut off.

13. Periosteum Elevator: For preserving the periosteum and elevating it from the bone before the bone is morcelled with the rongeur. A smaller periosteum elevator of the same pattern can be used in the radical and modified radical operations, to elevate the dermo-periosteum of the canal in order that it may be preserved intact for assistance in the wound repair.

14. Fine-angle Forceps (Blake): Useful for removing small foreign bodies, small hard crusts or pieces of desquamated epithelium from the canal and middle ear. Also useful in the application of artificial drum membranes.

15. Long-shafted Aural Speculum: For use in close inspection of the drum membrane in cases where the external canal is collapsed.

16. Aural Specula, assorted sizes (Gruber's): For use in different-sized meati.

17. Mastoid Wound Retractor (Jansen): One retractor is placed in each angle of the wound for the exposure of the excavation.

18. Powder Blower (Davidson): This powder blower regulates the dusting of powder, controlling it from a thin dust to a solid stream. It is used to insufflate powder into the meatus and middle ear and to dust wounds. This blower can be transformed into a middle-ear powder blower by fitting it with a short rubber tube to which a middle-ear canula is adjusted.

19. Middle-ear Syringe and Canula: For syringing out the middle ear for discharge or epithelial crusts or for intratympanic application of solutions.

20. *A.* Piano-wire Cotton Applicator for the Meatus (Blake): These applicators are bent at an angle to allow inspection of the canal, during the process of wiping.

B. Fine Middle-ear Probes (Blake), silver, olive tip: For exploring in the tympanum.

C. Fine Middle-ear Cotton Applicator (Blake), silver: For wiping recesses of the middle ear and for medicinal applications to the middle ear.

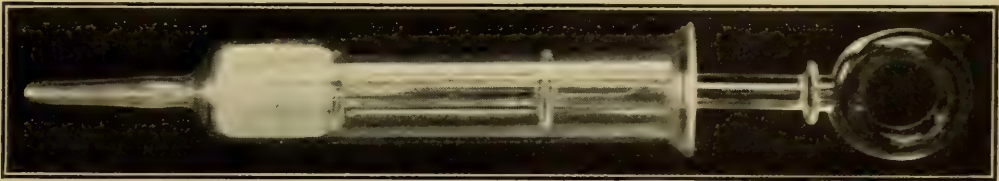


FIG. 230.—Three ounce glass piston syringe with asbestos packing.

21. Three Middle-ear Curettes (Blake), malleable shafts, one straight, two bent at an angle: For removing pathological growths or accumulations from the middle ear. The angular limb of the shaft is made in two lengths for reaching different distances. The shafts are malleable to allow making special angles at the tip.

22. Three Assorted Curettes (Richards): For cutting forward into bone.

23. Three Assorted Curettes (Blake): For cutting sideways into bone and for enlarging an opening in the bone.



FIG. 231.—*a*, Two-ounce soft rubber ear syringe; *b*, soft rubber syringe tip, detachable.

24. Front Bent Gouge: For accurate carving of the mastoid bone, either superficial or deep.

Fig. 230, glass piston syringe, asbestos packing: For syringing the meatus for removal of foreign bodies and impacted serum, or for washing the meatus. The syringe can be boiled.

Fig. 231, soft rubber ear syringe, a good syringe for syringing the canal. Especially good for family use, as it can do little damage

and can be boiled. Rubber syringe tip, for use on a piston syringe to lessen danger of injury. The tip can be boiled.

Fig. 232: 1. Otoscope: For auscultation of the Eustachian tube and middle ear. The ends of the tube can be fitted with glass, metal or bone ear pieces, or the tube may be used without the ear pieces.

2. Politzer's air bag for Politzerization and catheterization.

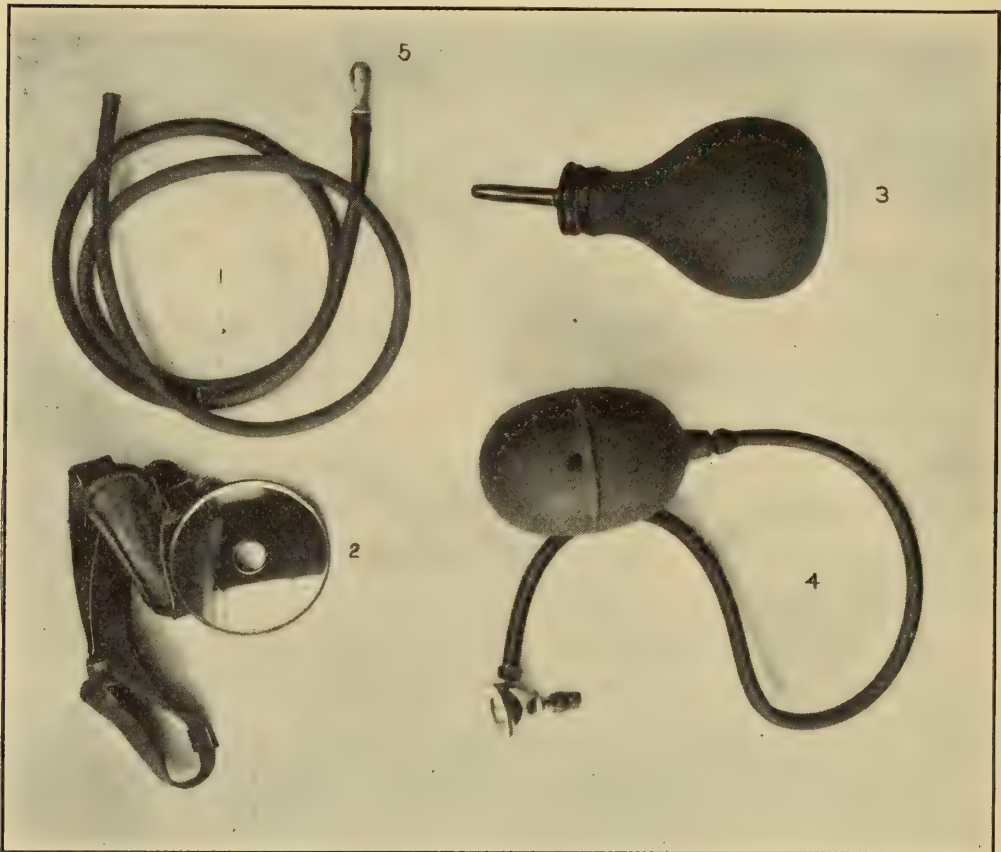


FIG. 232.—1. Three feet of one-fourth inch rubber tubing for otoscope. 2. Politzer's air-bag. 3. Forehead mirror with five-eighths inch aperture and head-band. 4. Siegel's otoscope. 5. Ear tip for otoscope.

In Politzerization a soft rubber tube is put on the tip of the bag. In catheterization the tip of the bag is shaped to fit the end of the catheter, but not to stick in it. In catheterization no connecting tube is used.

3. The forehead mirror with a large aperture, is used to permit less accurate adjustment than a mirror with a small aperture. The focus of the mirror should not be over six inches. The head band may be of any pattern convenient to the operator.

4. Siegel's otoscope consists of an aural speculum with the large end closed air-tight with a glass plate, through which the drum-membrane may be observed. The barrel of the speculum is united

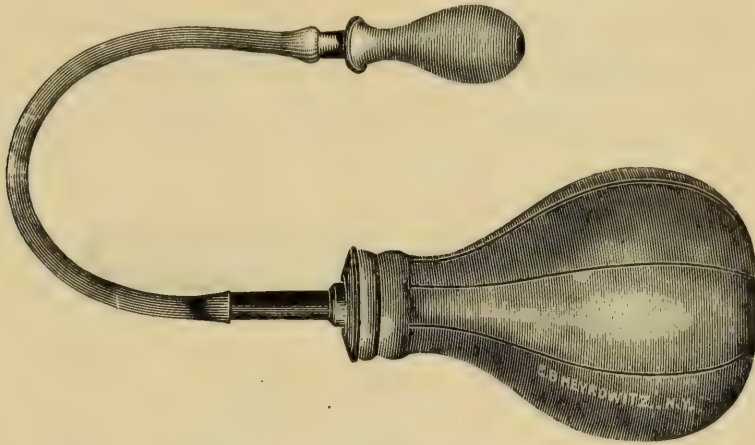


FIG. 233—Poltzer Bag.

by a tube with a rubber suction or compression bag. The tip of the speculum is fitted tightly into the ear so that by rarefaction or compression of the air in the bag, the movements which the drum membrane will make may be observed through the glass.

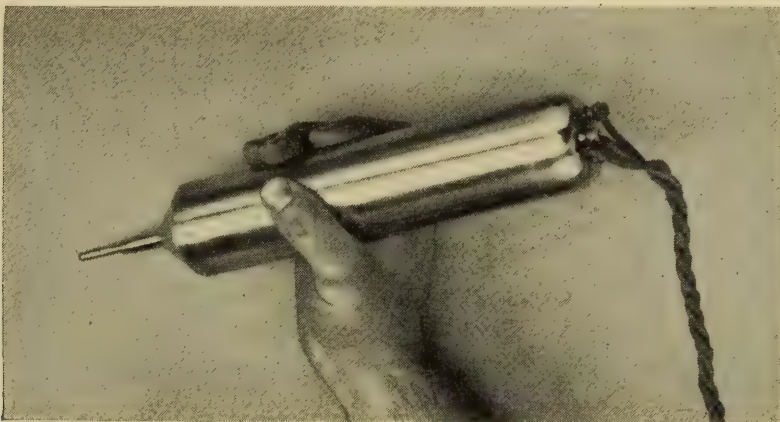


FIG. 234.—Author's Surgical Electric Engine, held in the hand ready for use. The burr is seen. It has but one cutting edge. Description of motor: $\frac{3}{10}$ horse-power; 3 phase; 10 volts; 15,000 revolutions per minute; 185 cycles; 2 poles; diameter $2 \frac{1}{8}$ inches; length of barrel, $9 \frac{1}{2}$ inches; weight, 7 lbs. 5 ozs.

Fig. 234.—Surgical Electric Engine: This motor can be used as a drill, as a burr to enlarge a bone cavity, as a fraise to cut an osteoplastic flap, and as a trephine. The entire motor and cords are sterilizable.

OTHER SPECIAL INSTRUMENTS.—Edelmann's Galton whistle; Politzer's acoumeter; Eustachian salpingoscope; Victor surgical engine and author's burrs; tuning forks with movable clamps—one 24 to 36 single vibrations, one 36 to 70 single vibrations, one 70 to 104 single vibrations, and one for 192, 256, 512, 1,024, 2,048, 4,096, and 8,192 single vibrations. Watch with average tick; stop watch; author's phonographic acoumeter for accurate voice test;

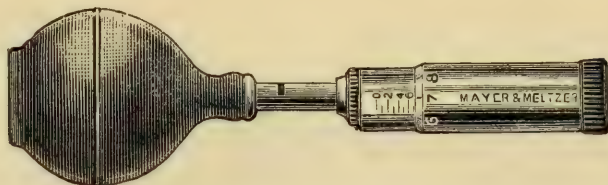


FIG. 235.—Galton's Whistle.

small sterilizer for gas, electricity, or alcohol—size 8 x 3 inches. In addition, the ordinary instruments—scalpels, scissors, needles, needle-holders, forceps, artery clamps, Sprague's ear hot-water bag, and fountain syringe are required.

STERILE DRESSINGS.—Toothpick-wipes—toothpicks wound with cotton at the tip; absorbent cotton; absorbent cotton pads 6 x 6 inches; rubber tissue; small gauze sponges free from lint, or sea sponges; gauze handkerchiefs 12 x 9 inches; two-inch roller bandages; iodoform or formalin gauze strips one inch wide and one and one-half inches wide.

PROCEDURES.

TYMPANIC INFLATION.

Valsalva's Method.—To inflate the tympanum by Valsalva's method, the patient should hold the nose hermetically sealed between the thumb and finger, and should try to blow air out through the nose until the compression of the air is sufficient to force it through the Eustachian tube. To facilitate the passage of air into one ear, the patient should look toward that side and tilt the chin up.

Poltzerization or Politzer air douche. The hard-rubber tip of the Politzer bag is covered with a piece of soft-rubber tubing. The tip is then placed in the nostril of the patient. With his left hand, the observer closes the nostrils firmly about the tube, in order that

no air may escape. The patient is now told to blow hard from his chest into his cheeks. When the cheeks are sufficiently hard, the air bag, grasped firmly in the observer's right hand, is quickly compressed to force the air into the tympani. During the test, the observer should have his ear connected with the patient's ear by an otoscope (Fig. 232, No. 1). Air will be forced into the ears if the

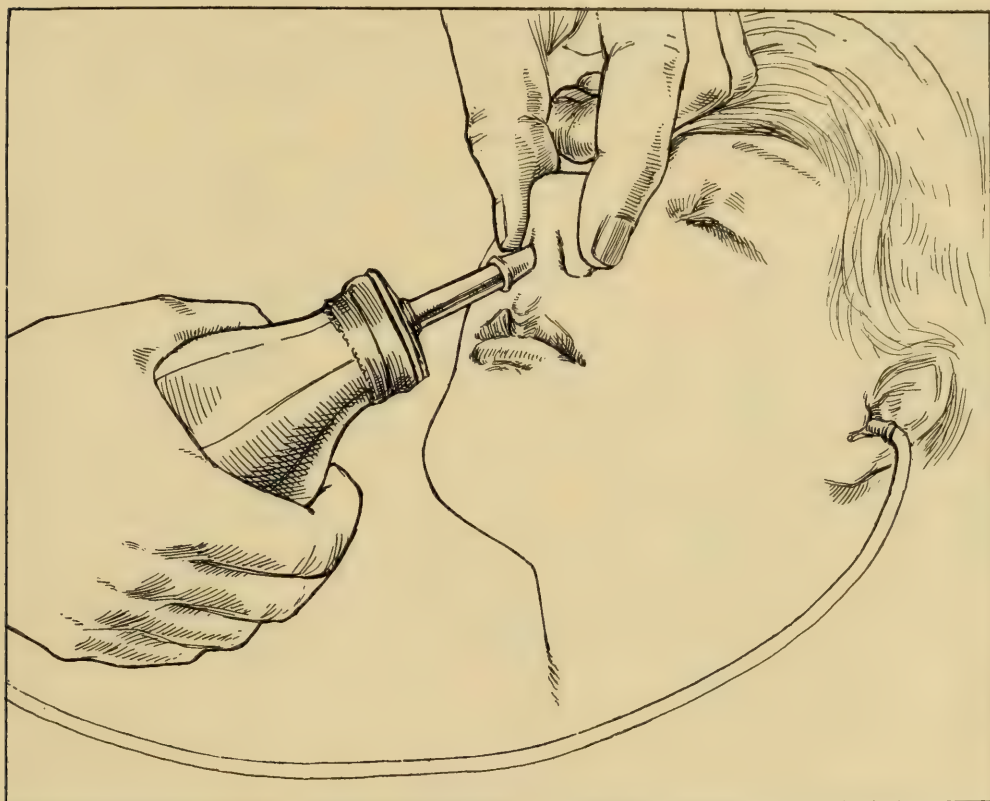


FIG. 236.—Poltzerization. The covered tip of the air bag is inserted in the patient's nostril. The nostrils are then compressed by the first finger and the thumb of the observer's left hand, while he squeezes the bag with his right hand, meanwhile the patient opens the tube by one of the three methods described. The otoscope is seen in the patient's left ear.

Eustachian tubes are patulous and if the velum palati is firmly retracted.

Another method of Politzerization: The patient should say "Hook! Hook! Hook!" or "Chocolate! Chocolate! Chocolate!" or "Ha! Ha! Ha!" The observer squeezes the bag during the act of phonation. The following is the best method of Politzerization: the patient holds a drop of water in his mouth and swallows it on the word from the observer. As the observer sees the larynx rise, he squeezes the air-bag sharply.

Catheterization.—Insertion of the catheter. The observer should first blow through the catheter with the Politzer air-bag in order to be sure that the catheter is clear and contains no fluid. A medium-sized catheter, with a medium curve, is best. The tip of the nose is lifted upward by the observer's left thumb and the beak of the catheter, pointing downward, is inserted well into the lower meatus.

The observer releases his hold on the handle of the catheter and allows the catheter to swing between the first finger and the thumb of his right hand. The right hand of the observer is raised until

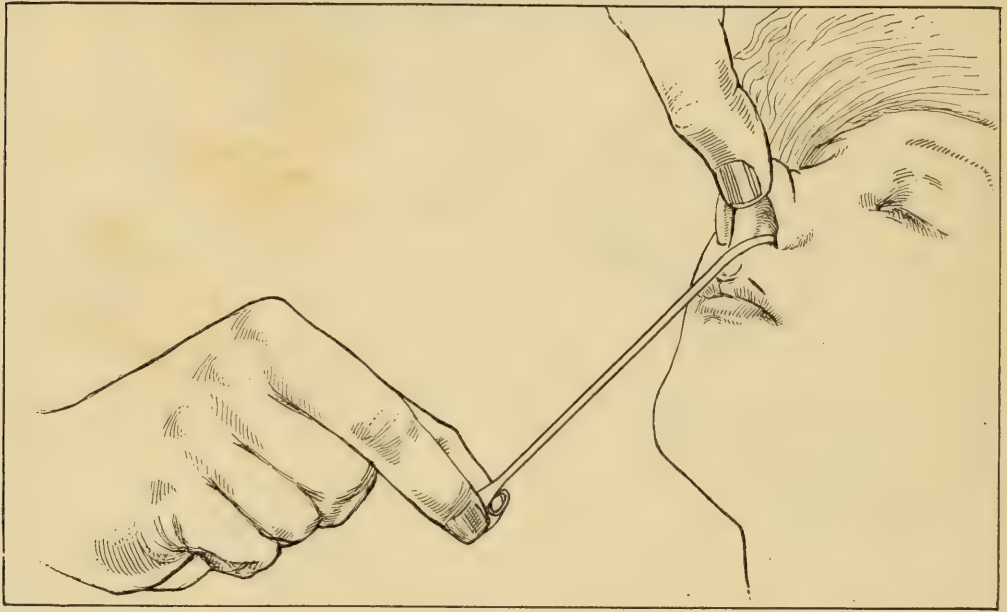


FIG. 237.—Introduction of Catheter; First motion: the tip of the nose is lifted by the thumb of the observer's left hand; the catheter is grasped by the index-finger and thumb of the right hand and inserted into the lower fossa of the side to be catheterized.

the shaft of the catheter touches the upper border of the nostril. With gentle forward pressure, the catheter is pushed in.

If the structure of the nose is normal, the catheter will pass in until it has reached the posterior pharyngeal wall. If an obstruction is encountered, the catheter should, by slight guiding movements, be allowed to find its own path through. The beak of the catheter should not be allowed to rise out of the lower fossa, or pass over a spur or obstructing turbinate. If the catheter will not proceed on gentle forward pressure the nasal fossa should be examined and the catheter inserted under observation with reflected light. If, upon inspection, the nasal passage appears to be much obstructed, the end of the catheter should be gently rotated in either direction,

and very slight forward pressure exerted. The catheter will then usually go in further. If it is impossible, on gentle pressure, to insert the catheter, a smaller catheter may be tried or the attempt discontinued.

When the catheter has been passed into the nasopharynx, its beak must be engaged in the tube. The tube can be found by several landmarks. The most accurate method is by pushing the catheter gently in against the posterior wall of the pharynx, then



FIG. 238.—Introduction of Catheter: Second motion: The catheter is held lightly by the forefinger and thumb, and raised till the shaft touches the upper border of the nostril, then it is gently pushed or dropped in.

rotating the beak of the catheter outward, directing the beak into the fossa of Rosenmüller. Press the handle of the catheter slightly against the septum, and draw it out slowly for about one-half inch. In doing this, one feels the beak of the catheter slip over the alar cartilage of the tube. As it slips, the handle of the catheter should be sharply pressed against the septum, and the beak rotated upward and outward toward the outer canthus of the eye while the catheter is pushed in until it is fixed in the tube. Then with the use of the air

bag, as shown in the diagram, the air is blown through the catheter into the ear.

Another method of inserting the catheter into the tube: After passing the beak of the catheter into the nasopharynx, the beak is rotated 45° toward the opposite side, and the catheter drawn gently outward until the beak catches on the posterior edge of the nasal septum. The beak of the catheter is then turned downward

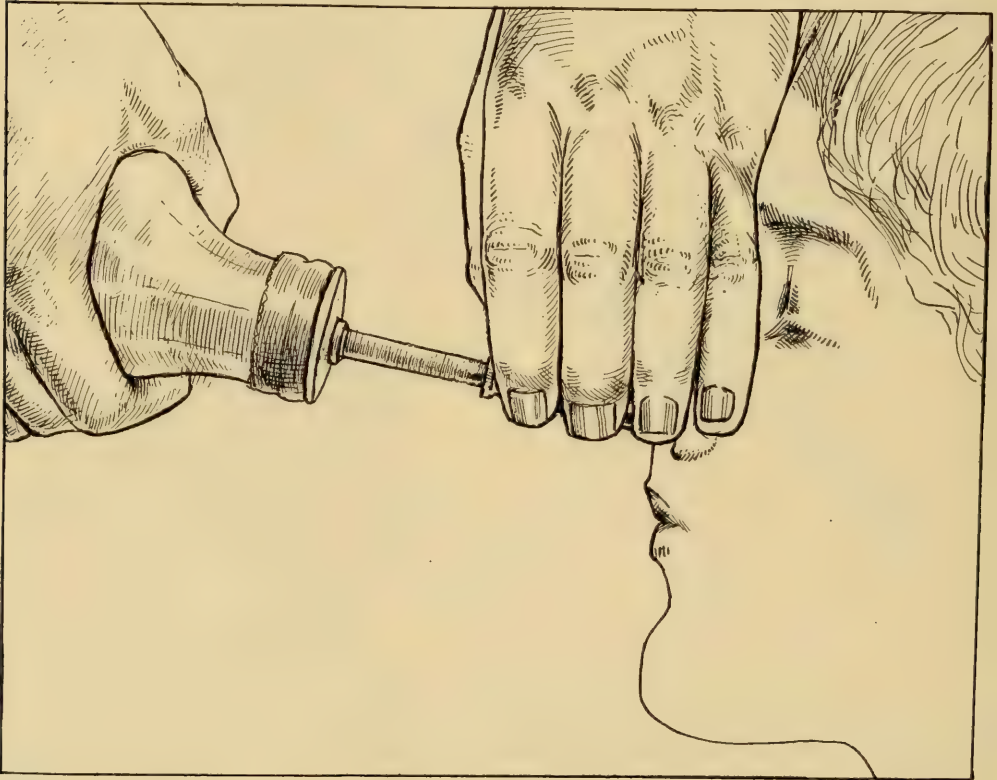


FIG. 239.—Introduction of the Catheter; Third motion: After the beak of the catheter has been placed in the Eustachian orifice, the catheter is grasped firmly by the observer's left middle and index-finger and thumb, while the edge of the hand rests firmly on the forehead of the patient. The tip of the air-bag is inserted into the catheter and the bag is squeezed.

and toward the ear to be catheterized, making a turn of 180° . The shaft of the catheter is pressed against the nasal septum. The beak is rotated upward toward the outer canthus of the eye of the same side, and backward pressure made at the same time. The beak of the catheter will usually engage in the tube by this method.

To recover the catheter it is gently grasped between the thumb and index-finger of the right hand, drawn outward to free it from the tube, released and again grasped, when it is led rather than

pulled out. If any obstruction is met, the patient should lean his head down and gravity will quickly free the catheter.

It is possible to catheterize from the opposite side, but with less satisfactory results. The technic of catheterizing the Eustachian tube from the opposite nostril is as follows: The catheter should have a longer curve than the catheter previously used—about one and one-half times as long an arc, on a radius about one-half again as large as the size of the first one. The catheter passed through the opposite nostril is engaged in the mouth of the tube by rotating the beak toward the ear to be catheterized, drawing the catheter gently out until the beak catches on the posterior edge of the septum. The shaft of the catheter should then be pressed sharply against the outer wall of the nasal fossa, making a slight backward pressure. At the same time the beak of the catheter is rotated slightly upward (15° to 20°) when the beak will usually engage in the tube.

In exceptionally nervous cases, cocainization of the lower fossa of the nose and lateral pharyngeal wall will greatly facilitate catheterization. The beak of the catheter easily penetrates the mucous membrane when it is anesthetic. Force must always be avoided for fear of making a false passage and thereby causing emphysema.

Hommel's Massage.—This massage is applied to the tragus by the tip of the index-finger. The index-finger is pressed firmly against the cheek in front of the tragus and drawn backward until the tragus slips back from under the finger.

Vibratory Massage.—This massage may be applied with any form of vibrator, preferably using a low rate of speed—500 to 1,000 impulses per minute. A rubber cup is used and vibration is applied to the mastoid process, external auditory meatus, and under the angle of the jaw.

Syringing.—In syringing, always use warm water. The operator should always make sure that the return flow of the water is unobstructed. In syringing for cerumen and foreign bodies, use a piston syringe (Fig. 230), water at 99° temperature, and a tablespoonful of borax to a quart of water. Expel all the air from the syringe before using. Open the external auditory meatus with the left hand by upward and backward traction on the auricle. Backward traction on the auricle should be used for adults, and downward traction for infants. Place the tip of the syringe just in the meatus,

pointing it inward, upward, and backward, and use considerable force in propelling the water. Short sharp squeezes of the syringe, and relaxation on the auricle, alternately, is the best method. In syringing for the removal of discharge and soft material, use a syringe with a soft rubber tip with slight pressure (Fig. 231).

For hot douching, use a fountain syringe with a soft-rubber tip, and water 108 to 112° or hotter if it does not hurt the patient. Apply no more force than is necessary to cause the water to flow into the ear.

For middle-ear syringing, use the middle-ear syringe (Fig. 229, No. 19) with the solution at 99°. Expel all the air from the syringe before using. The syringing should be done under direct inspection through an aural speculum and with reflected light.

APPLIANCES.

Artificial Drum Heads, Tympanic Splints, and Tympanic Ballast.—Artificial drums of various patterns may be bought or may be made in the office. Paper disks of thin, sized paper can be cut to fit over the defect in the tympanic membrane and placed in position with the angle forceps or cotton carrier. Thin cotton pledgets moistened with vaseline can also be used to close perforations in the membrane.

Tympanic splints to bring the major ossicles in better apposition can be made with the paper as described above and placed in the auditory canal, resting against the lower wall of the canal and the short process of the hammer. Contractile collodion, which is painted over the relaxed area, serves as a contracting splint when the drum membrane is relaxed. Tympanic ballast made of pledgets of cotton soaked with vaseline can be applied to the promontory and fenestræ, when there is loss of the membrane and the major ossicles.

Poltzer plugs may be made of cotton soaked in cocoa-butter and moulded into a conical acorn-shaped plug, to fit tightly into the meatus.

Sterile absorbent cotton wicks for tympanic drainage are applied by drawing the auricle up and back and inserting the wick with the angle forceps. The wicks should reach the drum, but not touch it. A piece of sterile cotton is placed in the concha covering the wick.

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